Engineering Library

'THE ENGINEER," FEBRUARY 28, 1930

With METALLURGICAL SUPPLEMENT.

The Engineer.

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OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXLIX.—No. 3868] LONDON: FRIDAY EVENING, FEBRUARY 28, 1930 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director-General,

India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—

SCHEDULE 1.—NINE LOCOMOTIVE BOILERS, 4-6-0 type.

SCHEDULE 2.—14 SPANS of 155ft. 6in. (about 1512 tons).

Tenders due as follows :—

Schedule 1, 1st April, 1930, 2 p.m.

Schedule 2, 11th April, 1930, 10.30 a.m.

Forms of Tender, available from the above at a fee (which will not be returned) of 5s. for each Schedule. 4541

Board of Education.

APPOINTMENT OF AN ASSISTANT AT THE SCIENCE MUSEUM.

The Board of Education invite APPLICATIONS for APPOINTMENT as ASSISTANT on the HIGHER TECHNICAL STAFF of the LIBRARY in the SCIENCE MUSEUM.

Applicants must have attained the age of 22, and as a rule must not have exceeded the age of 30 on 1st April, 1930, but in exceptional cases applications from persons above the age of 30 on that date will be considered. Candidates who have served in H.M. Forces, or as established Civil Servants, may be allowed a deduction from actual age.

Candidates will be expected to have had a training equivalent to that required for a University Honours Degree in Engineering, together with a knowledge of one or more modern languages.

The beginning salary for Man Assistants entering at the age of 25 or over is £250 per annum, plus current Cost of Living Bonus. The beginning salary for an Assistant entering below the age of 25 will be £200, rising to £250 on attaining 25. Assistants are eligible for promotion to posts with a maximum salary of £900 per annum plus bonus.

The beginning salary for Woman Assistants entering at the age of 25 or over is £230 per annum, plus bonus. Woman Assistants entering below the age of 25 will receive an initial salary of £190, rising to £230 on attaining the age of 25.

The current Civil Service Cost of Living Bonus is added to salary. At present the bonus on £190 is £95; on £200, £99; on £230, £106; and on £250, £111.

A fee of £8 will be payable by successful candidates before certification.

Further particulars and application forms may be obtained from the DIRECTOR and SECRETARY, Science Museum, South Kensington, London, S.W. 7, and the application form when filled in should reach the Director not later than the 22nd March, 1930. 4543

Crown Agents for the Colonies.

COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/2015.—ASSISTANT ENGINEERS (8) REQUIRED by the GOVERNMENT OF NIGERIA for the PUBLIC WORKS DEPARTMENT, for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480 a year for the first three years; then £510, rising by annual increments to £920. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates must have attained the age of 21½ years on the date of appointment, and should preferably have attained the age of 22½, and must not be over 25 years of age. Must have obtained an Engineering Degree at a recognised University or have passed Sections "A" and "B" of the A.M.I.C.E. Examination or have passed the Associateship in Civil Engineering of the City and Guilds Institute, or possess such other Degree or Diploma or Distinction in Engineering as may be considered satisfactory. Candidates whose qualifying diplomas have been obtained without a college course, should have had three years' practical experience of Civil Engineering under a qualified Civil Engineer. It is preferred that all candidates should have had two years' practical experience on good engineering work, subsequent to taking their degree or completing their articles, but under certain conditions this may be waived in the case of candidates in possession of an Engineering Degree.

M/1950.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of TANGANYIKA TERRITORY for the Dar es Salaam Harbour Scheme, for a tour of 20 to 30 months' service. Salary, £480, rising to £600 by annual increments of £20, and thence rising to £720 a year by annual increments of £30. (The question of paying a higher commencing salary than the minimum of the foregoing scale will be considered in the case of a highly qualified candidate.) Outfit allowance of £30 on first appointment (provided the commencing salary is not over £600 a year). Free quarters and passages, liberal leave on full salary. Candidates not over 40 years of age, must be fully qualified Civil Engineers, who have had experience of Block-making and Block-setting in connection with Harbour and Dock Works.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 4540

The High Commissioner

for India REQUIRES an ASSISTANT ENGINEER INSPECTOR (Mechanical) for service in England. The post is on a non-pensionable basis and will be held in the first instance on probation for two years, during which period the services of the incumbent may be dispensed with at one month's notice. Thereafter service will be terminable by six months' notice on either side.

Salary £150, rising by annual increments to £300. Prospect of £310, rising by annual increments to £400 by promotion to Inspector. These salaries carry a variable cost-of-living bonus on the Civil Service scale. At present the bonus on £150 amounts to £82.

Candidates should be 28 to 35 years of age, have good technical and shop training and have held some position of responsibility. All-round rather than specialised experience is desirable. Preference given to A.M.I. Mech. E. or equivalent. Previous inspection experience not essential.

Applications, stating age, training and experience, and enclosing copies of recent testimonials, to be sent to the DIRECTOR-GENERAL, India Store Department, Belvedere-road, Lambeth, S.E. 1, not later than 14th March, 1930. 4513

The Engineer

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PUBLIC NOTICES

Department of Scientific and Industrial Research.

An ENGINEER is REQUIRED at the Building Research Station, Garston, near Watford, Herts, for work mainly in connection with research on Steel Structures. Candidates should have a good honours degree, or its equivalent, with experience in research and in the practical design of steel structures.

Scale of salary £350-£20-£450 plus Civil Service bonus and superannuation provision under the Federated Superannuation System for Universities. At the present rate of bonus a salary of £350 corresponds to a payment of £485 per annum.

Application forms can be obtained from the SECRETARY, Department of Scientific and Industrial Research, 16, Old Queen-street, Westminster, S.W. 1, to whom they should be returned not later than 10th March. 4512

Factory Premises

(KINGSWAY ENGINEERING WORKS), Clapington-road, Dundee, by PRIVATE TREATY; main block (built 1925) consists of extensive Machine Hall, Administrative Offices, &c. Centrally heated, electric light, power and gas installations; also other Factory Type Buildings, Stores, &c. Could be adapted for use as garage and workshop. Site area about 5 acres. May be inspected on application to the Caretaker on the premises.—Further particulars from DIRECTOR OF LANDS AND ACCOMMODATION, H.M. Office of Works, King Charles-street, London, S.W. 1; or H.M. OFFICE OF WORKS, 122, George-street, Edinburgh. 4470

University College, Southampton.

Council invites APPLICATIONS for the CHAIR of ENGINEERING. The salary will be £1000 per annum and duties will begin 1st October, 1930.

Particulars of the appointment may be obtained from the Registrar, by whom applications must be received not later than the 22nd April.

GEORGE GRANT,
4507 Registrar.

PUBLIC NOTICES

PATENTS AND DESIGNS ACTS, 1907 TO 1928.

Notice is Hereby Given that

BABCOCK and WILCOX, Limited, of Babcock House, 34, Farringdon-street, London, SEEK LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 185,314, granted to Babcock and Wilcox, Limited, Herbert Henry Baker, and Christopher Samuel Davy, for an invention entitled "Improved Means for Distributing the Fuel on to the Grate Surface of a Stoker."

Particulars of the proposed Amendment were set forth in No. 2144 of the "Illustrated Official Journal (Patents)," published on the 19th February, 1930.

Any person or persons may give Notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of publication of the said "Journal."

W. S. JARRATT,
4505 Comptroller-General.

Cornwall County Council.

TORPOINT FERRY.

TENDERS are INVITED for the CONSTRUCTION of LANDING BEACHES and RE-FORMING EXISTING BEACHES including FORMATION of DAMS, STEEL SHEET PILING, TIMBER PILING, CONCRETE REVETMENTS and SURFACE WORKS at Torpoint, Cornwall, and Devonport, Plymouth, in accordance with plans and specification prepared by Mr. H. Victor Prigg, Chartered Civil Engineer, Plymouth.

Plans and specification may be seen at the office of the Ferry Manager, Torpoint, Cornwall, or at the Engineer's Office, South Devon Chambers, Millbay Station, Plymouth, on and after Monday, the 3rd March, 1930.

A form of Tender and bill of quantities may be obtained from the Engineer on payment of Two Guineas, which will be returned upon receipt of a bona fide Tender.

The lowest or any Tender will not necessarily be accepted.

Tenders must be delivered to the undersigned not later than Noon on the 15th March, 1930.

T. A. H. SHEERS,
Deputy Clerk of the County Council.
County Hall, Truro,
24th February, 1930. 4515

PUBLIC NOTICES

Administrative County of London.

The London County Council invites separate TENDERS for the SUPPLY and ERECTION in Blackwall Tunnel of :—

CONTRACT No. 1.—(a) FOUR ELECTRICALLY DRIVEN EXHAUST PROPELLER FANS, 8ft. diameter, each with 15 B.H.P. MOTOR; and (b) TWO CENTRIFUGAL BLOWING FAN SETS, each with 55 B.H.P. ELECTRIC MOTOR, and STEEL SUCTION and DELIVERY AIR DUCTS.

CONTRACT No. 2.—FOUR STEEL LATTICE GIRDERS, various STEEL JOISTS, PLATFORMS, &c., for supporting the fans to be installed under Contract No. 1.

The specifications, forms of Tender, &c., may be obtained on application to the Chief Engineer, the Old County Hall, Spring-gardens, S.W. 1, upon payment in each case of £5 by cheque, draft or money order to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer, the Old County Hall, Spring-gardens, S.W. 1. Personal inquiries at Room 3A, No. 3, Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 24th March, 1930, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
4509 Clerk of the London County Council.

Bengal-Nagpur Railway Company, Limited.

The Directors are prepared to receive TENDERS for :—

836 ROUGH STEEL ENGINE TYRES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Thursday, 27th February, 1930.

A fee of 10s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than Noon on Tuesday, 11th March, 1930.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
P. W. GIBBS,
4538 Assistant Secretary.

Bengal-Nagpur Railway Company, Limited.

The Directors are prepared to receive TENDERS for :—

PLATE GIRDER BRIDGES (20, 40 and 60ft. Clear Deck Spans).

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Wednesday, 26th February, 1930.

A fee of 10s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than Noon on Wednesday, 12th March, 1930.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
P. W. GIBBS,
4521 Assistant Secretary.

County Borough of Belfast.

SUPPLY OF TWO MECHANICAL CONCRETE MIXERS.

The Improvement Committee invite TENDERS for the SUPPLY of TWO MECHANICAL CONCRETE MIXERS.

Forms of Tender and particulars may be obtained at the office of the City Surveyor, Mr. R. B. Donald, M. Inst. C.E., City Hall.

Sealed Tenders, on forms provided, enclosed in the envelope supplied with the Tender form, endorsed with the name and address of the firm tendering, and marked "Tender for Concrete Mixers, Surveyor's Department," to be lodged or posted so as to arrive in the office of the undersigned not later than Friday, 14th March, 1930.

An official receipt must be obtained for every Tender delivered by hand. Tenders sent by post should be registered. The Corporation do not bind themselves to accept the lowest or any Tender, but the whole or any part of a Tender may be accepted.

R. MEYER,
4527 Town Clerk.

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PUBLIC NOTICES

Battersea Borough Council.

NINE ELMS BATHS.
LANCASHIRE BOILERS, ECONOMISER AND WATER SOFTENING PLANT.

The Council invite TENDERS for the SUPPLY and ERECTION of the following PLANT at their Nine Elms Baths and Wash-houses, Battersea Park-road, S.W. 8 :—

(A) TWO LANCASHIRE BOILERS, each capable of evaporating 6500 lb. of water per hour at a working pressure of 100 lb., with average coal and draught, also a STEEL CHIMNEY.
(B) ONE 96-TUBE PIPE ECONOMISER, suitable for a working pressure of 100 lb.
(C) WATER SOFTENING PLANT, capable of dealing with a maximum of 3500 gallons of water per hour.

Forms of Tender, containing full particulars and plan, may be obtained at the Town Hall, Lavender-hill, S.W. 11, between 10 a.m. and 4 p.m. (Saturdays, 10 a.m. to 1 p.m.), or by sending me stamped addressed envelope under cover, endorsed "Tender Form."

Tenders, in separate envelopes, sealed and marked on the outside "Tender for ——," must be delivered to me by 10 a.m. on Monday, 24th March, 1930.

The Council do not bind themselves to accept the lowest or any Tender, and they reserve to themselves the right to accept the whole of or any portion of a Tender.

EDWIN AUSTIN,
Town Clerk.

Town Hall, Battersea, S.W. 11.
27th February, 1930. 4536

Metropolitan Water Board.

TENDER FOR THE SUPPLY OF THREE WATER-TUBE BOILERS, SETTINGS, SUPER-HEATERS, ECONOMISERS, PREHEATER, PIPING, FEED PUMPS AND ASH HANDLING PLANT, &c., AT SURBITON PUMPING STATION.

The Metropolitan Water Board invite TENDERS for the SUPPLY and ERECTION of THREE WATER-TUBE BOILERS, SETTINGS, SUPERHEATERS, ECONOMISERS, PREHEATER, PIPING, FEED PUMPS and ASH HANDLING PLANT, &c., at their Surbiton Pumping Station, Portsmouth-road, Surbiton, Surrey.

Forms of Tender, conditions of contract, specification and drawings may be inspected without payment of a fee at the offices of the Board, Chief Engineer's Department (Room 173), on and after Wednesday, 5th March, 1930.

Contractors desirous of tendering may obtain the necessary documents from the Chief Engineer on production of an official receipt for the sum of Three Guineas, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings. Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. and 12 Noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Boilers, Surbiton," must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Tuesday, 15th April, 1930.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
24th February, 1930. 4517

South Indian Railway Company, Limited.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. PLATELAYERS' TOOLS.
2. WOOD HANDLES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked :—"Tender for Platelayers' Tools," or as the case may be, with the name of the firm tendering, must be left with the undersigned not later than 12 Noon on Friday, the 14th March, 1930.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 2s. 6d. for each copy of each specification.

Copies of drawings may be obtained at the Offices of the Company's Consulting Engineers, Messrs. Robert White & Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France,
Westminster, S.W. 1.
26th February, 1930. 4542

Required, Qualified Civil Engineer

for an English Drainage Company in South America. The position is a senior one and carries a high salary with excellent prospects for the right man.

Applicants must have had good training, preferably with contractors.

A knowledge of a modern Latin language would be an advantage, but is not essential.

Letters should give full particulars of age, education, qualifications, previous employment, and when disengaged. Age should not exceed 35.

Write, Box "S.," c/o Messrs. Davies and Co., 95, Bishopsgate, London, E.C. 2. 4537

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED by Old-established Clyde Firm, a First-class MAN as ASSISTANT to ENGINEER DIRECTOR. Age about 30 to 45. Must be courteous, tactful and well skilled in recent Admiralty and merchant practice and have received a good technical education.—Address, 4522, The Engineer Office. 4522 A

WANTED, for Service in the Near East, TWO YOUNG SURVEYORS, age between 22 and 27; single, used to Topographical Work, quick Levellers and capable of Simple Triangulation Work.

Starting salary, £450 per annum, with free quarters. Apply :—

IRAQ PETROLEUM COMPANY, Ltd.,
King William-street House, Arthur-street, London, E.C. 4. P6741 A

CONSTRUCTIONAL STEEL WORK DESIGNER for Cinema Work REQUIRED for London Consulting Engineer's Office. State experience and salary expected.

Address, P6723, The Engineer Office. P6723 A

ENGINEERING ASSISTANT REQUIRED in the Research Department of a large English Engineering Firm. Candidates should be graduates in physics or engineering, and some works experience is desirable. The work would be of a general character, but a knowledge of the fundamentals of heat transmission and fluid motion would be an advantage, and applicants should refer to their experience in these matters.—Address full particulars of qualifications, training and experience, with copies of recent testimonials 4473, The Engineer Office. 4473 A

PRACTICAL MAN REQUIRED to Supervise Plate Shop. Experience necessary in Sheet Steel Working, Tank Making and Arc Welding. State age, experience and salary.—Address, 4506, The Engineer Office. 4506 A

SALES ENGINEER.—APPLICATIONS are INVITED by British Manufacturers of Cranes, Transporters, etc., from YOUNG MEN who are ambitious, with Drawing Office and Works experience. Full particulars of qualifications, salary expected (in confidence).—Address, 4508, The Engineer Office. 4508 A

LEASE OF IMPOSING OFFICES FOR SALE.

33, NORFOLK STREET, STRAND, W.C. 2.

In consequence of the recent amalgamation of "THE ENGINEER" LTD., proprietors of "The Engineer," with MORGAN BROS. (PUBLISHERS) LTD., proprietors of "The Ironmonger" and "The Chemist & Druggist," the offices of the three journals will shortly be transferred to new and more commodious freehold premises which have been acquired at 28-31, Essex Street, Strand, W.C. 2.

The remainder of the lease, covering a further twenty-five years, of the present offices of "The Engineer" at 33, Norfolk Street, Strand, W.C. 2, is in consequence for sale. This particularly well lighted five-storey building has an area of 8,200 sq. ft., and occupies a site at the corner of Norfolk and Howard Streets, adjacent to the Temple Station, whence Westminster and the City may be reached in a few minutes. The building is of modern construction and has a fine and distinctive elevation. It is in good order throughout, and vacant possession can be had in June next. Rent £1 600. Moderate price. For further particulars apply to :—

WHATLEY, HILL & CO.,
24, Ryder Street, St. James', S.W. 1.

Genuine opportunity occurs for Gentleman to Invest Small Capital and take over Management of LIGHT CASTING FOUNDRY IN MIDLANDS. Previous experience essential and own connection desirable. Auditors' figures.—Applications, treated confidentially, in first instance to 4535, The Engineer Office.

SITUATIONS OPEN (continued)

THE BRUSH ELECTRICAL ENGINEERING CO., Ltd., of Loughborough, invites APPLICATIONS for the POSITION of WORKS SUPERINTENDENT of their Engineering Department. The manufacture embraces Steam Turbo-generators and Electrical Machinery of all types. Applicants must have had experience in similar capacity.—Letters, giving full particulars of career and salary required (which will be treated confidentially), should be addressed to the SECRETARY of the Company, Falcon Works, Loughborough 4476 A

WORKS MANAGER WANTED for Electric Motor Factory. Must be a good organiser and prepared to start 7.30 a.m.

Applicants must state age and salary required and the names of their present and past employers, which will be treated with utmost confidence.

Experience in Machine Tool Operation, Tool Making, Press Work and Foundry a recommendation. Some electrical experience desirable.

Address envelopes "V.," Higgs Motors, Witton, Birmingham. P6728 A

WANTED, DRAUGHTSMAN, Experienced in the Design of Superheated Steam Locomobiles. District East Midlands. State age, experience and salary required.—Address, 4511, The Engineer Office. 4511 A

WANTED, Experienced DRAUGHTSMAN for Civil Engineering Work with London Consulting Engineers.—Address, stating age, experience and salary required, 4544, The Engineer Office. 4544 A

WANTED, Young MECHANICAL DRAUGHTSMAN for Engineering Works in Midlands. Some knowledge of modern Building Construction an advantage. Please write, stating details of experience, age, and wages required.—Address, 4462, The Engineer Office. 4462 A

DESIGNING DRAUGHTSMEN, — SEVERAL WANTED by established Firm in South Midlands town. Considerable experience essential on High-speed Internal Combustion Engines.—Address, stating age, full experience, and salary required, 4529, The Engineer Office. 4529 A

DRAUGHTSMAN REQUIRED, About 30 Years of age, by a Large Firm of Furniture Manufacturers for the Engineering Department of their Tottenham Works.

Applicants must have had a good mechanical training, and preference will be given to those with experience in the design of Modern Woodworking Machinery.

The position holds out good prospects for the right man and all applications will be treated in confidence.

Apply by letter, stating age, experience, and salary required, to DRAUGHTSMAN, Harris Lebus, Finsbury Works, Tottenham, N. 17. P6721 A

DRAUGHTSMEN REQUIRED IMMEDIATELY : fully experienced Jig and Tool Designers. Only men having first-class experience of Jigs, Tools and Production Equipment for Automobile Work will be considered. State age and give full particulars of qualifications.—HENRY FORD and SON, Ltd., Cork, Ireland. 4524 A

DRAUGHTSMAN WANTED for South of Spain. Must have all-round experience, including General Steelwork and Mechanical Detailing. Knowledge of Mining Plant Machinery an advantage. Unfurnished quarters provided. Single man preferred, age not less than 25. Salary £300 to £350 a year.—Apply, S.D., c/o Streets, 6, Gracechurch-street, London, E.C. 3. 4546 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN, Experienced, for Quarry and Contractors' Machinery. State age, wage, and experience.—Address, 4459, The Engineer Office. 4459 A

DRAUGHTSMEN REQUIRED IMMEDIATELY ; must be accustomed to Modern Automobile Plant Layout and Installation, also have some experience in Light Steel Structures and Pipe Work. State age and experience.—HENRY FORD and SON, Ltd., Cork, Ireland. 4525 A

DRAUGHTSMEN, SENIOR, Having Sound Experience of Electric Control and Contactor Gear.—Applications, stating age, experience and salary required, with copies of references, 4415, The Engineer Office. 4415 A

DRAUGHTSMAN WANTED, Having a Thorough knowledge of Centrifugal Pumps ; experience in Feed-water Heaters an advantage ; Manchester district.—Address, giving full details of experience, also age, technical training, and salary, 4534, The Engineer Office. 4534 A

ENGINEER DRAUGHTSMAN or DESIGNER, experienced in making Detailed Designs and Calculations of Reinforced Concrete Construction Work.—Write, stating age, experience and salary required, to Z.G. 149, c/o Deacon's Advertising Agency, Fenchurch-avenue, London. 4545 A

JIG and TOOL DRAUGHTSMAN WANTED ; Toolroom and shop experience essential ; preference given to man with B. and S. and Multiple-spindle Auto. experience and Milling Machine Fixture design. Age 26-28. State age, experience in detail and salary required.—Address, 4526, The Engineer Office. 4526 A

JIG, TOOL and PLANT DRAUGHTSMEN REQUIRED by large Motor Car Firm in Midlands. Men with experience of Production Methods and Layout of Motor Car Manufacture only need apply.—Address, 4461, The Engineer Office. 4461 A

REQUIRED, First-class DRAUGHTSMAN for Structural and General Engineering Works in India. Applicants must have served full apprenticeship in structural engineering workshops with subsequent technical training at Engineering College or University and have obtained B.Sc. or B.E. Degree. Good appearance and address essential. Public school man preferred. Single, age 25/28. Must be well up in Structural Engineering, able to estimate, work out and check all calculations. Commencing salary Rs. 750 per month, rising to Rs. 950 ; 5 years' agreement.—Write in first instance to Z.R. 136, c/o Deacon's Advertising Agency, Fenchurch-avenue, London. 4528 A

REQUIRED, JUNIOR DRAUGHTSMAN, Exp. R with Colliery Screening Plants or similar. Quick, accurate detailer, age about 20 years. London residence.—Write, stating fully experience, training, and salary, to E. J. HIBBERT and CO., Vicarage-road, S.W. 11. P6731 A

SITUATIONS WANTED

CIVIL ENGINEER, British, M. Inst. E., M.I. Struct. E., M.R. San. I., &c., public school, foreign university education ; over 25 years' experience large irrigation, sewerage, railways, roads, water and other works, Russia, Persia, Mesopotamia, India ; seven years' executive position, Bombay Municipality ; lately resident engineer with the Foundation Company, Ltd., of London, on their contract works, SEEKS RESPONSIBLE TECHNICAL or COMMERCIAL APPOINTMENT abroad. Good linguist, highest references.—Address, 4472, The Engineer Office. 4472 D

SITUATIONS WANTED (continued)

COMMERCIAL MANAGER, with Wide Experience, machine tool and engineering, SEEKS SIMILAR or other RESPONSIBLE POST. Familiar with detail work and supervision all departments, commercial side, including secretarial work, accountancy, management and staff control. Able organiser, adaptable, modern. Sales experience inside and on road.—Address, P6739, The Engineer Office. P6739 B

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For continuation of Small Advertisements see page 4.

A Seven-Day Journal

British Lenses and Television.

In our issue of February 14th we reported certain statements that had been made concerning the difficulty which the Baird Television Company was alleged to have experienced in obtaining British lenses for the television sets which it intended shortly to place on the market. According to the statements which we quoted, the company had been obliged to accept a French tender because of a great disparity said to exist between British and French prices for the lenses and because of the lengthy delivery period asserted to be required by British firms. It is more than satisfactory to learn that there is no truth in any of these statements. It was alleged that the lowest British quotation received by the Baird Company was £500 for the supply of a thousand 6in. lenses and £200 for the supply of a like number of 4in. lenses, and that a French tender, amounting to £87 10s. for the supply of the thousand 4in. lenses, had been accepted. We learn that at least two of the leading British optical firms—Taylor, Taylor and Hobson, Ltd., and Ross, Ltd.—were never asked to tender for the work and that a third—the British Optical Lens Company, of Birmingham—received inquiries for it from two different London agents, or middlemen, but without being told for whom the lenses were required. This third company's quotations were £225 for the thousand 6in. lenses and £75 for the thousand 4in. It will be noted that not only did no great disparity exist between British and foreign prices, but that the British firm's quotation was actually less than the figure at which the order for the 4in. lenses was stated to have been placed in France. Further, the British firm undertook to give delivery in six weeks' time and not in three months, or over, as alleged. It may be added that the Baird Company disclaims responsibility for the original statements and asserts that it has not as yet asked for quotations for the supply of lenses in quantities. There is much that is mysterious about the situation, but one thing is clear. Anyone requiring optical lenses will be well advised to see that their inquiries go direct to the manufacturers. Good will come of the incident if it serves to place the users of lenses on their guard against statements reflecting on the ability of the British optical industry to compete with the foreigner, either in the matter of quality, delivery, or price.

Southern Railway Reorganisation.

Important changes in what is generally known in railway circles as the Traffic Departments are to be made on the Southern Railway as from March 31st. These changes are consequent upon the retirement on that date of Mr. H. A. Sire, the chief commercial manager. Until comparatively recent years an officer, known as the Chief Goods Manager, was, on all railways, responsible for the obtaining, delivery and dispatch of the goods traffic; whilst another, whose title was that of Superintendent of the Line, dealt with the passenger traffic. The latter officer was, however, also responsible for the working of all trains, even of goods trains, except in the goods yards. Although that arrangement was in force for a good fifty or sixty years—and yet remains on the Great Western—it has not been a happy one, as it was found better to separate the commercial and the operating sides. The commercial side was sometimes divided into goods and passenger. That scheme was adopted on the Southern, where it was constituted in 1923, but is now to be changed by the co-ordination of both departments under a traffic manager. That office is to be filled by Mr. E. C. Cox, who was the Superintendent of the Line on the South-Eastern and Chatham Railway and became chief operating superintendent of the Southern when grouping became operative. A change to be made on the same date is the retirement of Mr. Godfrey Knight, the secretary of the company, who was the secretary of the London and South-Western, but retired on the formation of the Southern Railway. Mr. J. J. Brewer, of the "Brighton," was made the secretary of the new company, but died soon after he had entered into his new office, and then Mr. Knight returned to railway service to fill the vacant position.

St. James' and Pall Mall Electric Light Company.

Speaking at the ordinary general meeting of the St. James' and Pall Mall Electric Light Company, Ltd., held on February 25th, the chairman of the company, the Right Hon. Gerald W. Balfour, explained that during the year the expenditure amounted to just over £80,000. By far the largest item consisted of expenditure on machinery and fixed plant and on mains, necessitated by the change over to the new standard alternating-current distribution system. A considerable amount of plant and mains unsuitable for the new system had been dismantled during the year, and the writing off of its cost had been met from the appropriate sinking funds. Negotiations in the direction of obtaining further sites for static transformer stations had been successful. In connection with the work of changing over the system from direct to alternating current, it might interest the shareholders to know that, by the end of 1929, 7304 kilowatts of load had been changed over, which was equivalent to 20 per cent. of the total connections at that date. The board was hopeful that by the end of the current year the new standard system would be available in all principal streets in the area, and unless unforeseen circumstances arose it would be unnecessary to incur heavy commitments on capital account for some years to come. The receipts from sales of electricity were less by £3778 than in the preceding year, although the units sold increased by nearly 5,250,000, compared with an increase of 4,000,000 units in 1928. Connections also showed a satisfactory advance from 35,626 to 38,609 kilowatts. The drop in revenue was attributable to two substantial reductions in the tariffs during the year, one in the lighting charges and the other in the charge for power, heating, and cooking purposes, together with a concession in the quarterly "minimum charge" for lighting supply. The charges for all classes of supply had been reduced considerably below the pre-war basis. For heating, power, and cooking supply the company's charge from Michaelmas, 1929, had been a flat rate of ½d. per unit—a tariff which would bear favourable comparison with that of any supply undertaking in the United Kingdom.

The Rolls-Royce Schneider Trophy Engine.

Until this week the Air Ministry has forbidden the publication of any details concerning the Rolls-Royce "R" engine with which the Supermarine seaplane that won the Schneider Trophy last September and subsequently established the world's speed record of 357·7 m.p.h. was fitted. It is now disclosed that the engine develops upwards of 1900 horse-power and weighs—presumably in the dry condition and exclusively of the radiation system—1530 lb. Its weight is, therefore, 0·805 lb. per horse-power, a figure which not so long ago would have been regarded as being outside the bounds of attainment. The engine measures 50in. in length and 30in. in width. Great as was the speed realised by the Supermarine machine, it is stated that the engine was capable of giving it a still higher speed, but was prevented from doing so by the fact that the airscrew was unable to absorb all the power of the engine. It is understood that the machine and its engine are shortly to be used for fresh high-speed tests. The engine has twelve cylinders of 6in. diameter and 6½in. stroke, and is fitted with a blower for boosting the air supply at ground level and with reduction gearing. The time available for the development of the engine was limited, but close co-operation between the Supermarine and Rolls-Royce Companies enabled it to be completed and tested with a considerable margin to spare for trials in flight. Very little trouble was experienced during the test flights, and in particular it was found that the engine possessed the ability to run at slow speeds without plug trouble.

A Suggested Engineering Trade Enquiry.

On Wednesday, February 26th, a joint meeting of the Federation of Engineering and Allied Employer and representatives of the engineering trade unions took place to consider the request of the unions that their claim for an increase of 8s. a week on time rates and a corresponding alteration to piece rates should be submitted to arbitration, failing which the unions should ask the Government to institute an inquiry into the engineering industry. Sir Allan Smith proposed to the representatives of the trade unions that they should appoint a joint deputation with the employers to investigate by personal visits the working conditions and cost of manufacture in foreign countries. Sir Allan pointed out the present difficult state of the industry and the serious effect of foreign competition, and made the suggestion that before proceeding further it was essential to arrive at the facts by means of the joint tour indicated. No details were given of the itinerary proposed, but it is understood that in the first place the inquiry would be conducted in continental countries and later, if the unions desired it, would be extended to America. The idea is that a small party should be formed representing both the employers and the unions, with an independent observer whom the Government would be invited to send, which could move about freely and carry out the investigations desirable in a comparatively short time. The representatives of the trade unions considered the employers' proposal and undertook to report it to a full conference of the unions to be called at an early date.

A New Experimental Tank at Teddington.

In the recent report of the Advisory Council for Scientific and Industrial Research, a summary of which will be found in our issue of February 7th, reference was made to the offer of the Department to subscribe a sum not exceeding £10,000 towards the cost of an additional experimental tank at the National Physical Laboratory at Teddington. The new tank is required to give increased facilities for the experimental and research work on ship resistance and propulsion, and the testing of ship forms and propellers, which is now being carried out at the "William Froude" National Tank. At the annual dinner of the Chamber of Shipping, which took place on Thursday of last week, February 20th, Mr. J. H. Thomas, the Lord Privy Seal, stated that as a result of representations made to him by the shipping and shipbuilding industries, the Government had decided to build a second tank for the testing of ship designs at Teddington, the cost of which would be £40,000. Mr. Thomas expressed the hope that the provision of additional testing facilities would result in the design of more efficient ships, and further stated his belief that the Blue Ribbon of the Atlantic was held by Germany only temporarily. We understand that the detailed designs of the new tank are now being considered by Mr. G. S. Baker, the superintendent of the Froude Tank, and his staff. The new tank will be specially designed for mercantile marine work, and will not, therefore, necessarily be so large as the "William Froude" National Tank, presented by Sir Alfred Yarrow, or the Rome tank, recently completed and described in our issue of November 15th, 1929, which, in addition to testing ship designs and propellers, will also be employed for naval and high-speed hydroplane work. Mr. Baker and his staff have for long laboured under great difficulties, and it is satisfactory to learn that additional facilities are now to be provided which should enable a larger amount of experimental work to be undertaken and to be dealt with expeditiously.

Proposed Atlantic Liners.

According to the shipping correspondent of one of our London daily contemporaries, the Cunard Line and the White Star Line are again addressing themselves to the problems attending the construction of large and fast liners for the North Atlantic service. The proposed new Cunard liner is credited with a tonnage of close upon 60,000 gross, and with high-pressure Parsons geared turbine machinery of something approaching 200,000 shaft horse-power. Her boiler plant will, it is stated, embody new principles of design, and a higher pressure than that yet adopted on other ships is to be employed. The speed of the ship, it is understood, will be such as to enable her to compete successfully with any other liner now proposed. The new liner for the White Star Line, our contemporary's contributor states, will be over 1000ft. in length, while her other dimensions will be such that she will be the largest liner in the world, probably exceeding 65,000 tons. As regards the question of her propelling machinery, the position would seem to be unaltered, and the rival claims of turbo-electric propulsion and oil-electric propulsion are still under consideration. Whatever truth there may be in the reports to which we have referred, there seems to be no doubt that our leading shipowners are determined to uphold British prestige on the North Atlantic service. In this connection, the trial results of the new North German Lloyd liner "Europa," which should be shortly available, will be of interest. Further particulars, it may also be noted, have recently been published concerning the two superliners which are to be built for the United States Lines, and which are to be ready in about two years' time. Each of these new ships will, it is understood, have a length of 962ft., with a beam of 107·5ft., and a measurement of about 53,000 gross tons. The propelling machinery will have a designed output of about 130,000 S.H.P., and will be of the high-pressure turbine type, capable of giving the vessel a speed of 28½ knots and over. The plans of the ships, it is stated, are now being considered by the United States Shipping Board and the Navy Department.

The Closing of the Penistone Steel Works.

In The Engineer for June 6th, 1923, and in the two succeeding issues we gave a full description of the Penistone Steel Works of Cammell Laird and Co., Ltd. Following the decision of the board of the English Steel Corporation, Ltd., some weeks ago to close down these works and transfer their activities to other works at Sheffield and Manchester, various departments have gradually been stopped, and on Saturday last the small rolling mill was shut down, and the remaining 300 men terminated their employment. Some of the skilled men have been transferred to other works of the Corporation, but practically all the men in Penistone are without employment. Deputations to the English Steel Corporation, Ltd., and to the Lord Privy Seal have endeavoured to obtain some modification of the decision of the board to close down the works finally and permanently, but without success. Mr. J. H. Thomas and Members of Parliament are interesting themselves in the possible sale of the works to some other industrial undertaking, but at present there seems to be little chance of an opening in this direction, as any sale would have to be made with due regard to the business of the Corporation. A feature of the works upon which we commented in our description is their excellent situation as regards railway connections and supply of water for industrial processes. There is also a good supply of labour available in the neighbourhood, and it is hoped that some means of providing useful employment for the displaced workers will eventually be found.

The Rolling of Metals.

By J. SELWYN CASWELL, M.Sc., A.M.I. Mech. E.

No. I.

THE aim in the following pages has been to discuss the rolling of metals in relation to fundamental principles. The rolling of metals is far from being an exact science, and practice in the art is to a large extent dependent on trial and error methods but the modern researches into the structure and the properties of metals and the increasing use of electricity for operating metal working tools and the consequent ease of measuring the power, is doing much to remove some of the chance experimental effort which is associated with it.

The plasticity of metals is discussed and the modern theories regarding the effect of applied stress on the behaviour and the properties of metals are given in outline.

The characteristics of the rolling mill as a deforming tool are considered, and the movement and the deformation of the stock between the rolls is discussed in relation to the simple processes of compression and extrusion.

The numerous factors which differentiate flow in the mill from that which occurs in simple compression are separately considered, and the views are summarised at the end of each section.

The energy requirements in the deformation of metal are of considerable importance to the engineer, and this subject is discussed from first principles and in relation to ideal conditions.

The discussion is extended to cover actual conditions, and consideration is given to the important subject of friction in rolling mills.

A general energy equation is developed for practical use, and an attempt is made to indicate its utility by applying it to actual rolling data, and the results are compared with the measured values of the energy requirements in the mills.

The principal purpose of rolling is to produce a change in the shape and the properties of a plastic substance. Plasticity is the property upon which all metal working processes depend, and it is important therefore that this property should be discussed at the outset.

PLASTICITY AND THE CLASSIFICATION OF PLASTIC SUBSTANCES.

The shape of plastic substances may be altered by the application of forces which are sufficient to produce relative molecular and atomic movement within the mass, without producing rupture. These substances may be broadly classified according to the manner in which the change of form is produced.

Substances which may be deformed continuously from the moment that a small force is applied can be classed as fluids of high viscosity. Pitch and sealing wax are examples of such substances, and they differ from what we commonly regard as a fluid, because the mobility of the molecules is very much lower.

The other class includes those substances, like the metals, which are not plastically deformed until the applied forces have reached some value at which the prevailing atomic arrangement can be disturbed beyond its elastic range. Most of the metals belong to this class, and mechanical tests of these reveal two distinctly different stages, viz., the elastic and the plastic stages. It is the plastic stage which is important, as far as the working of metals is concerned, because metal working processes are carried out within that stage.

The behaviour of substances of the second class, in the plastic stage, is in some respects similar to that of substances in the first class, viz., in the way in which flow takes place and in the similarity of the effects of the applied forces. It appears, then, that the term viscosity, as applied to fluids, may be applied with equal meaning to the behaviour of plastic solids, but the important difference, already referred to, suggests that it is necessary to limit this term to the substances which belong to the first class. The relation between the applied stress and the flow produced is not the same in each case, and the difference in behaviour is principally due to the presence of an elastic stage in plastic solids, during which no flow is produced.

The stress at which flow begins in plastic solids is called the yield stress, and the resistance to flow during the elastic stage is sometimes attributed to the internal friction of the material, although in the light of modern research it is more correct to regard it as due to the rigidity of the atomic space lattice.

Flow, in the case of plastic solids, is of a less perfect character than that in viscous fluids. In the former, plastic flow proceeds only to a limited extent under a given stress, whereas the flow of viscous fluids proceeds to an unlimited extent under a constant stress value. The imperfect plasticity of most of the metals is probably due to the heterogeneous arrangement of the crystalline and non-crystalline material which comprises the mass, and the changes in the physical properties which occur as the atomic arrangement is altered by applied stress. Two of the outstanding characteristics of the large single crystals of ductile metals which have been produced during recent years are (1) the disappearance of the hardness commonly associated with the metal; and (2) the very low values of the stress required to produce plastic flow. The crystal aggregate is less ductile, and this property and that of hardness, change considerably as the crystal size is diminished. These characteristics of the crystal aggregate led the late Sir George Beilby[1] to suggest that the plasticity of metals depends on the ratio of the crystalline and the vitreous or amorphous material in the mass.

THE EFFECT OF HEAT ON PLASTICITY.

Rolling operations are carried out on metals in the cold and the heated conditions, and the magnitude of the applied forces and the energy requirements depend on the character of the changes which take place in the metal when heat is applied. The application of heat to metals allows a readjustment of the cohesion bonds to take place, and while the ultimate effect is to diminish the strength of the bond and make metal working processes easier, there are very diverse changes in the properties of the material, and in particular in the plasticity, before that stage is reached.

The general behaviour of many of the alloys and pure metals, following the application of heat, may be summarised as follows:—

Iron and steel, and also some of the alloy steels, pass through a preliminary stage, during which there is a slight reduction in the tenacity and the ductility. This is followed by a slight increase and afterwards a continued decrease in the ultimate strength. After the preliminary decrease of the ductility there is a

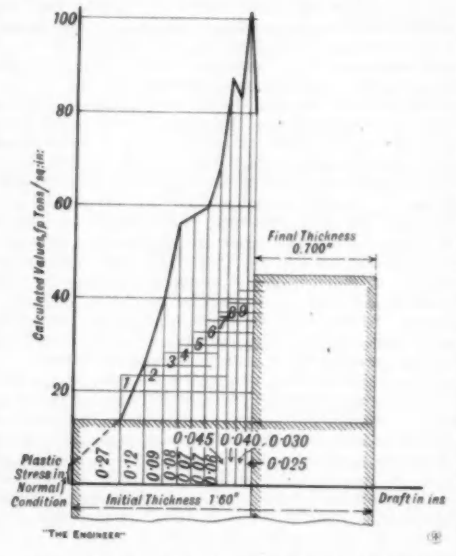

FIG. 1—CURVE OF PLASTIC STRESS VALUES

continuous increase with rise of temperature, while the elastic limit and the yield stress continue to decrease.

In the case of the non-ferrous metals there is at first an increase in the ductility, and this is accompanied by a decrease in the hardness and the ultimate strength. At a later stage the ductility falls off until at last successful working of the metal is not possible.

In the softer metals the elastic stage disappears almost entirely as the temperature is increased, and the plastic behaviour approximates closely to that of very viscous fluids. The creep tests of metals at high temperatures show that above a certain temperature and stress value, extension, or what is commonly referred to as "creep," occurs continuously until fracture takes place.

It appears, therefore, that the ultimate effect of the increasing application of heat on the workable metals is to make their plastic behaviour more nearly like that of the highly viscous fluids. It is probable that the similarity is not complete except at temperatures which are beyond the usual temperatures at which metals are worked. The plastic properties of a metal are also dependent on the relation which its temperature bears to the temperature limits of its solid phase, and the dissimilarity in the plastic behaviour of different metals may be related to this difference between them.

Although the conditions under which the flow of metals is produced vary widely, there is reason to believe that the way in which flow takes place is similar to the flow of liquids. Some of the earliest and most important work on this subject was carried out by Tresca[2], and his conclusion was "that the particles of solid bodies, when subjected to sufficient pressure, flow in the same way as liquids."

ROLLING AS A METAL WORKING PROCESS.

The flow of metal varies widely, according to the manner in which the metal is worked, *e.g.*, by forging, stamping, drawing, rolling, &c. Although the initial thermal condition and the physical properties are the same, the flow of the metal will depend on the magnitude and the rate of application of the stress, and also on the mass of the metal and the shape of the deforming tools. These are factors which sometimes render laboratory test data unsuitable for the designing of metal working plant. In rolling operations it is important to relate the work to be done between the rolls to the capacity of the driving unit, and the necessity of this is well illustrated in the cold rolling of metals. Hardening takes place rapidly with each reduction of the cross section, and the extent to which this occurs is shown in Fig. 1. The plastic stress values plotted on the diagram were calculated by the writer from the energy figures quoted by Ellis[3] in his paper on "The Effect of Work on Metals and Alloys," and they indicate the necessity of arranging the pass programme to suit the capacity of the driving unit. The points of inversion on the diagram are matters of special metallurgical interest, and they are widely discussed in connection with Professor Ellis's paper, but they do not come within the range of a general discussion such as this.

There are two principal methods of driving a pair of rolls, viz.: (*a*) by a positive drive to each roll; and (*b*) by a positive drive to the bottom roll only, the top roll deriving its motion from the frictional effort exerted on the surface of the bottom roll. The manner in which the deforming forces are applied when rolling is in progress is not the same in each case, and the difference between the methods, as they affect the distribution of the deforming forces, has been discussed in a previous paper.[4] The present purpose is to discuss the characteristics of rolling under a symmetrical distribution of the deforming forces, and the following conditions will be assumed:—Flat rolls of equal diameter, with the top roll set vertically above the bottom roll; a positive drive to each roll, with torques of equal value; and all parts of the stock in the same physical condition. The distribution of the deforming forces will then be perfectly symmetrical about the horizontal mid-section plane through the stock.

Movement of the stock between the rolls is effected entirely by the frictional effort exerted by the face of each roll. The limiting angle of the "bite" depends on the frictional characteristics of the surface of the rolls and the surface of the stock, and its value θ is equal to $\tan.^{-1} \mu_o$, where μ_o is the coefficient of friction of the surfaces in contact. Rolling is possible, within this limiting angle, as long as the resistance to deformation is less than the resultant force which can be exerted by the roll face, for the maximum torque which can be applied to each roll by the driving unit. The stress set up on the roll face, as soon as deformation commences, will be approximately equal to the static yield stress of the material in the undeformed condition. Over a certain range of temperature the value of the stress on the roll face will increase simultaneously with the progress of the entering stock towards the end of the "bite," and this is a matter which will be considered later.

A force p_o, Fig. 2, is set up on the face of each roll when the "bite" begins, and its value is equal to the resultant of the normal force p and a frictional force $\mu^1_o\, p$, in which the coefficient μ^1_o is some value, equal to or less than μ_o, such that the line of action of p_o is parallel to the common centre line C C of the rolls. As the "bite" proceeds there is a continuous application of the force p_o by each roll on opposite elementary areas at *a* and *b*, until these areas pass through the common centre line C C. The same remarks apply to every pair of opposite elementary areas, and deformation is continuous until the whole of the material has paassed between the rolls. The work on the rolls is therefore compressive in character, but this view must be discussed in greater detail later.

The foregoing is a general description of the way in which deformation is produced between a pair of rolls. There are, however, some important features of the operation which require separate discussion, and the first of them concerns the speed characteristics of the rolls as they affect deformation of the metal.

SPEED CHARACTERISTICS OF THE ROLLS WITHIN THE LIMITS OF THE "BITE."

In rolling practice the rate at which the stock leaves the rolls is called the rolling speed, and its value is commonly taken to be equal to the peripheral speed of the rolls in flat rolling, and the speed at the average pass diameter in section rolling.

The deforming speed of any elementary area of the roll face, and consequently the rate of deformation of the stock, will be much lower than the rolling speed, and its value, as will be shown later, depends on three factors, viz.:—

(*a*) The speed of rolling, *i.e.*, the angular velocity of the rolls,
(*b*) The diameter of the rolls, and
(*c*) The draught of the pass.

Referring to Fig. 2, the vertical velocity of a point *e* or *e'* is $\omega\, r \sin \alpha$, where ω is the angular velocity of the rolls. The "bite" angles are usually small, and therefore the instantaneous rate of deformation at each of

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[1] Beilby, "Aggregation and the Flow of Solids." Pub.: Macmillan.

[2] Tresca, "On the Flow of Solids," "Proc.," Inst. Mech. Engrs., 1867 and 1878.

[3] "The Effect of Work on Metals and Alloys," Ellis, Inst. Metals, Vol. XXI., 1919.

[4] "Forces and Energy Requirements in Strip Rolling," J. S. Caswell, "Proc.," Birmingham Metallurgical Society, Vol. IX., No. 7, Oct., 1927.

the points e and e' is approximately $\omega\, r\, \alpha$ (α being the angular measure in radians). The vertical speed of any point is, therefore, proportional to the angle α, and it varies from the maximum value $\omega\, r\, \theta$ at the beginning of the "bite" to 0 at the end of the "bite."

The retardation of the point e or e' is $\omega^2\, r \cos \alpha$, and for small angles, is very nearly equal to $\omega^2\, r$, and thus its value remains nearly constant during the "bite."

Since both roll surfaces approach each other with the velocities discussed above, the real speed of deformation at some given ordinate $e\, e'$ is $2\, \omega\, r\, \alpha$, the maximum value now being $2\, \omega\, r\, \theta$, and the maximum retardation is $2\, \omega^2\, r$.

The following deformation speeds, calculated from data kindly supplied by Messrs. W. H. A. Robertson and Co., of Bedford, will be of interest as an illustration of the respective values of the rolling speed and the speed of deformation.

Mill	High-speed rolling mill for strip brass
Diameter of rolls	10in.
Speed of rolls	96 r.p.m.
Rolling speed	250ft. per minute
Draughts in four passes	0·034/0·019in., 0·019/0·012in., 0·012/0·007in., and 0·007/0·005in.

The corresponding maximum speeds of deformation are as follows:—27·3ft. per min., 18·72ft. per min., 15·8ft. per min., and 10·0ft. per min.

The mean speed of deformation in the heaviest pass is, therefore, 13·7ft. per minute, or 2·74in. per second.

In sheet and tinplate mills the respective speed-values are as follows:—

Diameter of rolls	30in.
Speed of rolls	29 r.p.m.
Draught (max.)	¼in.
Approx. rolling speed	230ft. per minute
Maximum speed of deformation	58ft. per minute

The mean speed of deformation is therefore 29ft. per minute, or 5·8in. per second.

It is interesting to note that the speed of deformation in the latter case is much higher, although the speed of the rolls is much less, the difference being accounted for mainly by the larger roll diameter and the greater draught in the case of the sheet mill.

The horizontal velocity of the point e in Fig. 2 is $\omega\, r \cos \alpha$, and it varies from a minimum value of $\omega\, r \cos \theta$ at the point a to $\omega\, r$ at the end of the "bite." The acceleration varies from $\omega^2\, r \sin \theta$, or nearly $\omega^2\, r\, \theta$, at a, to 0 at the end of the "bite." Figs. 3 and 4, summarise the foregoing in graphical form.

It will be necessary to consider these characteristics further when the mechanism of deformation is discussed. They relate solely to the movement of the roll face within the range of the "bite." Movement of the stock is produced by roll face friction, and this is a matter for separate discussion.

The Movement of the Stock Between the Rolls.

There is a slight change of volume of the stock after it has been rolled, but it may be neglected for all practical purposes. It will be correct to assume, therefore, that the volume of the stock entering between a pair of rolls is not altered when the stock leaves the rolls. The spread which occurs during the progress of the "bite" is small in amount, and it depends mainly on the draught. Its effect in altering the width of flat stock is small, and it need not be considered at this stage.

Before discussing the movement of the stock, it is necessary to define the term "slip," which will be used frequently. It refers to movement of the stock, either by sliding relative to the roll face or relative movement between different parts of the stock, with or without the occurrence of slip over the roll face, for the maintenance of the constant volume flow condition to and from the pass.

If no slip occurred, the speeds of the stock at entry and exit would be those just discussed, and shown in Fig. 3, and the volume of the stock passing the planes $a\, b$ and $c\, d$ in Fig. 5, would be as follows:—

$T\, b\, \omega\, r \cos \theta$, across $a\, b$, and $t\, b\, \omega\, r$, across $c\, d$, in cubic inches per sec,

where T is the thickness of the stock before the pass in inches,
t is the thickness of the stock after the pass in inches,
b is the width of the stock before and after the pass in inches,
ω is the angular velocity of the rolls in radians per sec.,
θ is the angle of the "bite" in radians,
r is the radius of the rolls in inches.

In the real case the volumes passing these sections will be the same, and if it is assumed that no slip occurs at entry then the velocity at exit must be:—

$\frac{T\, b\, \omega\, r \cos \theta}{t\, b} = \frac{T}{t}\, \omega\, r \cos \theta$, instead of the roll face speed $\omega\, r$, and if, on the other hand, there is no slip at exit, the entry speed must be:—

$\frac{t\, b\, \omega\, r}{T\, b} = \frac{t}{T}\, \omega\, r$ inches per sec., instead of the roll speed $\omega\, r \cos \theta$.

When the draughts are small the angle of contact is also small, and both $\frac{T}{t}$ and $\cos \theta$ are nearly equal to unity. The velocities of the roll face and the stock, under both of the assumed conditions, will then be almost identical.

With greater draughts there is a greater difference between the speeds of the roll face and the stock. If it is assumed that there is no slip at entry, the exit speed will be greater than the roll face speed. This conclusion follows from an examination of the first of the expressions just referred to. It will be seen that the exit velocity is proportional to $\cos \theta$ and also to $\frac{T}{t}$, and the variation of the value of $\cos \theta$ is opposite to that of the ratio $\frac{T}{t}$, the value of $\cos \theta$ becoming smaller as the value of $\frac{T}{t}$ is increased. The distance between the roll centres is given by the expression $2\, r \cos \theta + T$, and for a constant thickness at exit, viz., t, it will be a constant. Then an increase in the value of T will be accompanied by a decrease of half that amount in the value of $\cos \theta$. The ratio $\frac{T}{t}$ will increase at a faster rate, therefore, than the decrease in the value of $\cos \theta$, and consequently the exit speed would be always greater than the peripheral speed of the roll when there is no slip at entry.

The other alternative supposition is, no slip at exit, and since it has been shown that the exit velocity is increased when there is no slip at entry, it follows, with the present supposition, that the velocity of the entering stock would be reduced, *i.e.*, there must be a slipping back of the stock over the face of the roll.

It is probable that neither of the foregoing suppositions represents the actual conditions, because the material at entry and exit is not as stress-bound as the material between these points, and therefore slip may occur at entry and exit simultaneously. The total amount of slip which occurs will be that required to maintain the constant volume condition through the pass. Osborne Reynolds[5] has shown, in his experiments on rolling friction, that although slip occurs on the forward and rear parts of the contact area, there is an area confined to the middle zones over which no slip occurs, and it is not improbable that such a condition holds when metal is rolled. The approximate position of the no-slip zone may be obtained as follows:—

The horizontal velocity of the stock against the roll face in the no-slip zone will be equal to the horizontal component of the roll face velocity at that point, and it will be assumed that X X, Fig. 5, is the plane of no slip, its position being defined by the angle α.

The velocity of the stock across this section $= \omega\, r \cos \alpha$.

Let the velocity at entry $= V_i$
And the velocity at exit $= V_o$
Then slip at entry $= \omega\, r \cos \theta - V_i$
And slip at exit $= V_o - \omega\, r$.

The volumes passing the sections $a\, a$, X X and $b\, b$ will be equal. Therefore $T\, b\, V_i = t_x\, b\, \omega\, r \cos \alpha = t\, b\, V_o$.

$$\therefore \frac{T}{t_x} = \frac{\omega\, r \cos \alpha}{V_i} \text{ and } \frac{t}{t_x} = \frac{\omega\, r \cos \alpha}{V_o}$$

By the geometry of the figure

$$t_x = t + D\,(1 - \cos \alpha).$$

$$\therefore \frac{t}{t + D\,(1 - \cos \alpha)} = \frac{\omega\, r \cos \alpha}{V_o}$$

and
$$V_o = \frac{\omega\, r \cos \alpha\, [t + D\,(1 - \cos \alpha)]}{t} \quad . \quad . \quad (1)$$

For the passage of equal volumes across $a\, a$ and $b\, b$ the slip volumes must be equal, *i.e.*,

$$T\, b\, (\omega\, r \cos \theta - V_i) = t\, b\, (V_o - \omega\, r),$$

and
$$V_i = V_o \frac{t}{T} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$\therefore T\, \omega\, r \cos \theta - V_o\, t = t\, V_o - \omega\, r\, t,$$

and
$$V_o = \frac{\omega\, r\, (T \cos \theta + t)}{2\, t} \quad . \quad . \quad (3)$$

By equating (1) and (3), and cancelling similar terms,

$$\cos \alpha\, [t + D\,(1 - \cos \alpha)] = \frac{(T \cos \theta + t)}{2}$$

$$t \cos \alpha + D \cos \alpha - D \cos^2 \alpha = \frac{T \cos \theta + t}{2}$$

or
$$D \cos^2 \alpha - (t + D) \cos \alpha + \frac{T \cos \theta + t}{2} = 0$$

$$\therefore \cos \alpha = \frac{t + D \pm \sqrt{(t+D)^2 - 4\, D \left(\frac{T \cos \theta + t}{2}\right)}}{2\, D}$$

$$= \frac{t + D \pm \sqrt{t^2 + D^2 - 2\, D\, T \cos \theta}}{2\, D}$$

But
$$\cos \theta = \frac{D/2 - (T - t)/2}{D/2} = \frac{D - T + t}{D}$$

$$\therefore \quad \alpha = \cos^{-1} \frac{t + D \pm \sqrt{t^2 + D^2 - 2\, T\, (D - T + t)}}{2\, D} \quad . \quad (4)$$

[5] Osborne Reynolds, Collected Papers.

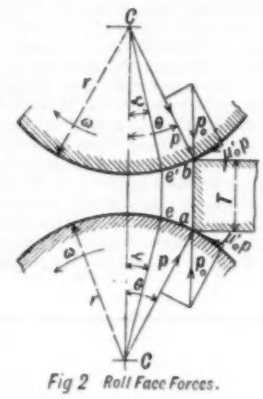


Fig 2 Roll Face Forces.

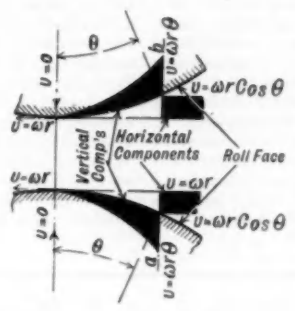


Fig 3. Roll Face Velocities.

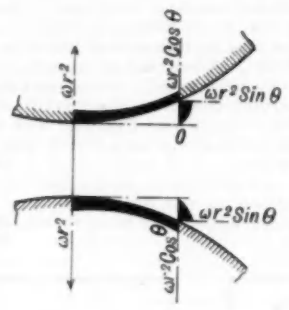


Fig 4. Roll Face Accelerations.

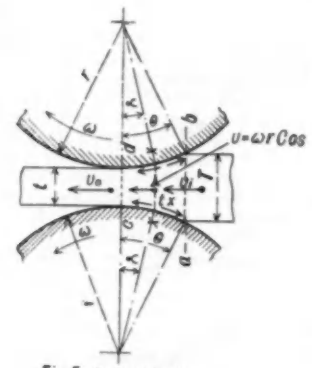


Fig 5. Stock Velocities

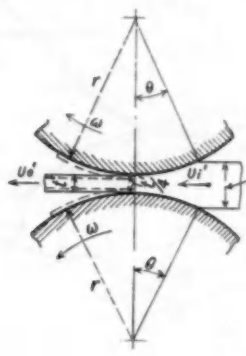
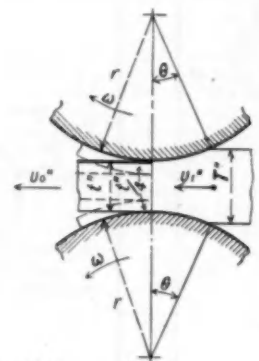


Fig 6.



Stock Velocities at Exit.

Fig 7.

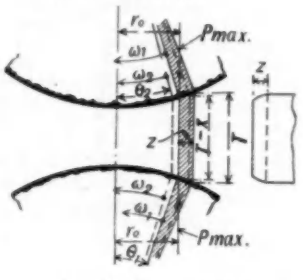


Fig 8. Elastic Compression.

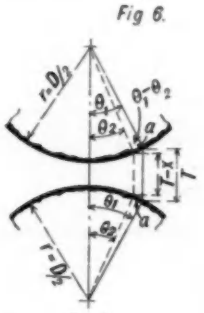


Fig 9.

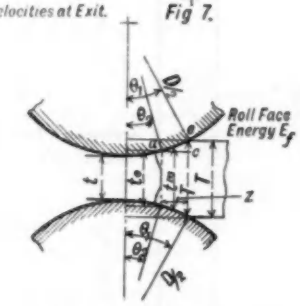


Fig 10. Early Stage of "Bite".

"The Engineer"

FIGS. 2 TO 10

which expresses the value of α in terms of the easily measured values T, *t*, and D.

The following example will indicate the approximate relationship between the no-slip angle α and the contact angle θ.

Example.

Roll diameters	30in.
Thickness of stock before the pass	10in.
Thickness of stock after the pass	8in.
Angle of no-slip section	14° 26′
Angle of " bite " or contact angle	21° 6′

(To be continued.)

The Punjab Hydro-electric Scheme.

By Colonel AUBREY O'BRIEN, C.I.E., C.B.E.

HIGH up in the Himalayas, in the little State of Mandi, the first water power scheme of the Punjab is now advancing steadily. The installation of the construction plant alone took two and three-quarter years, and now the construction of the permanent works is making good progress. It has not been an easy affair to get going, for the work is being done thousands of miles from the manufacturers of electrical machinery, a thousand miles from the nearest port and a hundred miles from railhead. The snow-fed waters of the River Uhl at a height of 6000ft. have communications by snow, and now the driving of the main tunnel and other works are well advanced.

A light railway, 100 miles long, has been constructed from the broad gauge station at Pathankot through the attractive and populous valley of Kangra as far as the power-house itself, but most of the preliminary work had to be done when there was nothing better available than a badly aligned mountain road rising up to 4000ft. over a distance of 100 miles, but with many switchbacks on the route.

When the tunnel has been completed, water from the Uhl will pass through it and by the effect of its being dropped down a pipe line for 2000ft., 36,000 kW of electrical energy will be developed at the power-house. This will be the first instalment of utilisation of the waters of the Himalayas for the benefit of the Punjab Province. It alone will be no mean undertaking, for the capital cost will amount to slightly over £4,000,000, with an annual upkeep of £375,000. There will be 176 miles of 132 kV primary transmission lines to Lahore and 200 miles of branch lines at 66 kV. Power will be distributed over an area which includes twenty of the most important towns in the very centre of the Punjab, such as Lahore, Amritsar, Ludhiana, Lyallpur and Ferozepore. It is expected that power can be delivered to the network at 3·3 pies per unit and to mills at 7·1 pies per unit, which is slightly more than a halfpenny. No thermal installation in the district could possibly compete with that figure, and it is, therefore, expected that has been made on the Uhl within the Mandi State, the rest of the sites are situated in British territory, mainly within the lovely valley of Kulu. The next valleys likely to be taken in hand are those of the Parbati and Sainj, which, midst beautiful scenery, can provide another 145,000 kW. Then it should be mentioned that when the Sutlej is harnessed by the immense dam already projected for irrigation purposes for the benefit of two million acres, it will be possible by passing the water through a tunnel under a hill 3500ft. high to develop 80,000 kW. This latter scheme was the first to be worked out, and the fullest calculations have already been made, but when the whole possibilities of the Himalayas were placed under survey, it was calculated that the Uhl scheme would be more economical.

It is somewhat surprising that while the Mandi project was in steady swing the Council of the Punjab should have demanded a committee, not merely to investigate the possibilities of stimulating the demand for the power, but with the suggestion that its scope should be cut down from 36,000 kW to 24,000 kW. To some extent this astonishing proposal is due to the hostility of certain capitalists, but there is a certain amount of nervousness with reference to a new thing, which has never been seen in the Punjab before and of which India so far has but little acquaintance. The committee appointed is a strong one, under the chairmanship of Sir Chuni Lal Mehta, formerly one of the Bombay Ministers, and on it,

FIG. 1—MAP SHOWING POSITIONS OF POWER-HOUSES

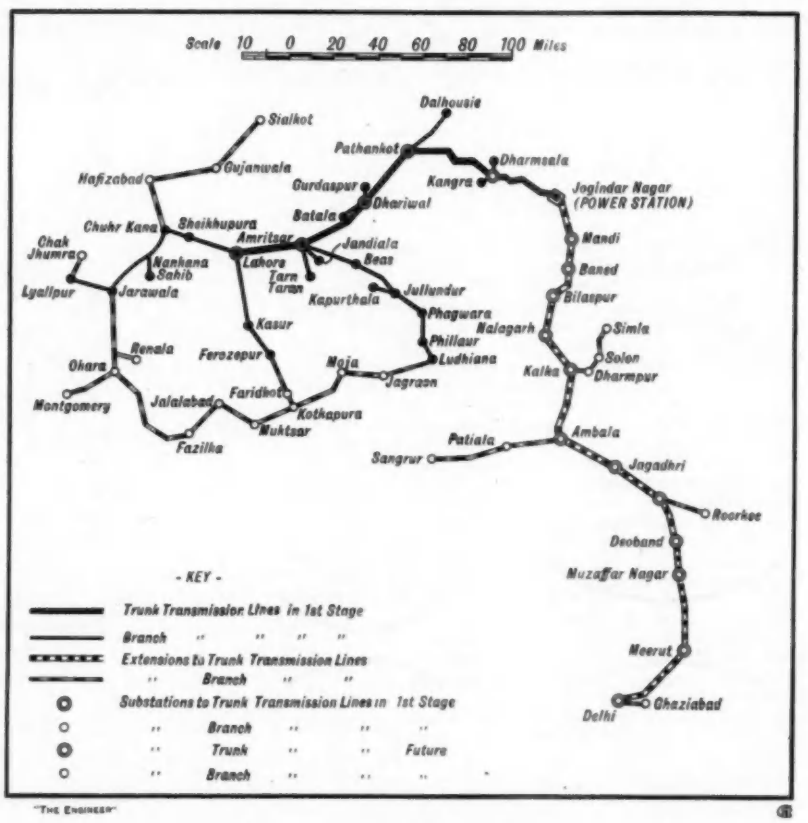


FIG. 2—MAP OF TRANSMISSION LINES

to be passed through a tunnel and dropped to the power-house at Shanan, which is at an elevation of 4000ft., on a desolate mountain road—see Figs. 1 and 2. The area of the works is traversed in the middle by what was originally an almost inaccessible range of hills rising to a height of 9000ft., which, in the early days of the undertaking, could only be climbed in places on hands and knees and took an active man two days to cross. The works in this area had to be carried on at four different levels; the headworks at 6000ft., railway communications at 8000ft., the tunnel headings on the south side at 6000ft., and the power station at 4000ft. The various levels had to be connected with haulage ways capable of rapidly raising loads ranging up to 15 tons in weight and 25ft. in length up and down hill. For construction purposes two complete hydro-electric plants had to be developed, distributing 1200 kW of electric power to the various points of working. To drive a modern high-pressure water tunnel through such a range necessitated the provision of services in each heading for high-pressure water, drainage pumping, high-pressure air, ventilation air, electric power supply, low-tension electric lighting, a direct-current trolley wire for electric locomotive, telephones and charge-firing cable, as well as a heavy narrow gauge railway with electric locomotives and rolling stock. Living accommodation for about three thousand workmen, one hundred and fifty engineers and subordinates and their families, together with water supply, sanitation, health and medical arrangements had to be constructed and all important points connected up by telephone. All this work has now been completed, despite the occasional complete blockage of all most of the industries already established will be ready to take the power offered. Schemes have been devised to make the change over easy for the manufactories concerned.

Should this first instalment of the Mandi project be successful, the future will see immense extensions. By sending on the water 1200ft. further down to a second power station at Kun, the peak capacity would be raised to 60,000 kW and power would be available for thirty-nine more towns, mainly in the direction of Ambala and Patiala, and the cost of the power delivered at any point in the network would be reduced to 6·2 pies. It is further proposed to construct a dam in the Uhl, 260ft. high, and when this is done the peak capacity would be increased to 120,000 kW, and power would be delivered on the one hand to the capital city of Delhi and certain areas of the United Provinces and within the Punjab as far as Jhelum. The cost of power would be again reduced to 5·3 pies.

This is not all, for the power capable of economic development on the seven rivers of the Punjab amounts to no less than 1,770,000 kW. A portion of the sites where such power is available lies within other Indian states, and negotiations would be necessary before they could be taken advantage of. The Kashmir State, for instance, has been reluctant, in the past, to sanction the use of its surplus water for irrigation or power within the Punjab. Nevertheless, considerably over 1,000,000 kW could be made available at regular intervals from the Swat river in the neighbourhood of Peshawar to the Jumna on the eastern border. The Beas, with its tributaries alone, can yield 830,000 kW, and although a start besides civilian members, are the Chief Engineer of Hydro-electric Development in Madras and the Chief Engineer of the United Provinces. Thus, it is improbable that there will be any real check to the enterprise. As a matter of fact, just as few dockyards are constructed which do not ultimately prove too small, so in the case in the provision of electrical energy the appetite comes with the eating. It is, of course, most essential that, considering the heavy outlay in capital cost and the additional initial sum required for tapping the high-voltage lines for the benefit of local areas, the utmost use should be found for the power as quickly as possible.

It is in agriculture in a province like the Punjab that the crux of the matter lies. Colonel Battye, the Chief Engineer of the hydro-electric branch, has, in making up his estimates of the probable use of the power, adhered, as is natural, to conservatism, and has only taken into account existing manufactories with the reasonable allowance for their expansion and for the demand for lights and fans, which, in the summer at any rate, is bound to be heavy. But the Punjabi, who is most enterprising and quick to adopt any mechanical device of the value of which he has been convinced, will have to be taught all that is known in the countries that already harness electricity to the needs of agriculture, and, if that is done, there is no reason to believe that he will be in any way backward in using the power at his command. The greatest assistance that can be given to agriculture in the Punjab is by the provision of water, and in the present case it has been calculated that electro-pumping could add six thousand cusecs to the visible flow supply, the equivalent of adding

another river to the province. Two and a half million acres, now dependent on rain, might be annually irrigated, while land, now waterlogged or under threat of danger as an unfortunate concomitant of the marvellous great canals, could be saved while the water is sent on to thirsty country elsewhere. It has again been calculated that, with the aid of gypsum which is abundant in the Salt Range, ammonium sulphate could be manufactured at cheap rates, and that, again, would mean a substantial increase in the outturn of cultivation, especially of sugar cane. Other agricultural uses may easily be thought of, and though in many areas holdings are small, the organisation of co-operative societies in the Punjab is now so advanced as to make combined effort easy. Another idea that has been considered, but not taken into calculation, is the manufacture of paper pulp out of the great forests of the Himalayas. Then, again, there are known to be minerals—lead, silver, copper and iron—in the valley of Kulu, which, at present, are unworkable because of their inaccessibility, but, with the opening up of the country as a concomitant of the present schemes, they are likely to become available. Given the power, further uses for it are bound to be found, especially among people as fertile in resource as those in the Punjab, of whom the Sikhs are notably skilled as artisans. It was only necessary to touch on the subject because of the timidity displayed in the province in dealing with a new and untried venture.

The dream of the future is for a complete network of transmission lines, or "grid," covering the North-West Frontier Province, the Punjab, the capital city of Delhi, and a portion of the United Provinces near the Jumna. There should be a main transmission line following the course of the Grand Trunk road from Delhi to Peshawar, into which power will be passed from the Swat Canal near the Malakand, from a site on the Haro River near Campbellpur, from a canal fall at the great headworks at Rasul, from the Mandi scheme already referred to, supplemented from other tributaries of the Beas and the Sutlej itself. Conditions are favourable for success, for the Bengal coal mines are about 1000 miles away, and though there is a small supply of oil at Khaur, near Rawalpindi, the price has been assimilated to world prices, raised high for India. There is no reason to doubt the forecast of industry as put forward by Lord Birkenhead. He expects that, in time, an intensive industrial life will grow up among the foothills of the Himalayan range, drawing its life-blood from great power stations high in the gorges and ravines of the mountains. A certain amount of danger to Indian prosperity is threatened by the conduct of Indians themselves. People of the type of Gandhi are the enemies of India, pulling back the Hindus towards the stagnation and mediævalism that are the causes of its poverty. Worse still, men of his type have caused a certain nervousness among investors, and, at the moment, India is not able to borrow as cheaply as she could a year ago. There are, however, signs that these forms of aberration are only temporary and that the general public refuses to be deluded by Gandhi once again. At any rate, though the Congress met at Lahore, both Mahommedans and Sikhs and a proportion of the Hindus of the Punjab were hostile to the foolish proposals passed at Christmas. The Punjab, at least, is thoroughly sane and anxious for the progress which British engineers have so abundantly bestowed upon it.

Institution of Mechanical Engineers.

ANNUAL GENERAL MEETING.

THE eighty-third annual general meeting of the Institution of Mechanical Engineers was held in London last Friday evening. The Council's report was carried unanimously without discussion or criticism. It showed that the membership roll during 1929 increased by a net addition of 279 names, and that the members on December 31st numbered 10,745. The membership is roughly divided as follows :—Associate members, 44 per cent.; members, 30 per cent.; students, 13 per cent.; graduates, 11½ per cent.; honorary members, companions and associates, 1½ per cent. At the Institution examinations held in April and October in London, the provinces and overseas, 79 candidates passed the studentship examination and 278 the associate membership examination or parts of it. Of the twenty-six papers, reports, addresses and lectures delivered before the Institution or its branches and subsequently printed in the "Proceedings," all but three were contributed by members.

Progress was made during the year with the steps necessary for obtaining for the Institution a Royal Charter of Incorporation. The petition was duly lodged and notice of it was published in the *London Gazette* on November 5th. It is understood that his Majesty is likely very shortly to signify his pleasure in the matter. Examinations for National Certificates and Diplomas in Engineering were held at 107 out of the 113 technical schools and colleges which now conduct approved courses of instruction. These examinations were attended by 1955 candidates, of whom 751 received ordinary and 290 higher certificates, and 25 ordinary and 22 higher diplomas. These figures relate to England and Wales alone. In Scotland 91 candidates and in Northern Ireland 42 candidates presented themselves for examination, and of them 77 and 18 respectively were successful.

The Alloys of Iron Joint Research Committee made considerable progress with its investigation of alloys of iron and silicon and hopes shortly to present an account of the work. The difficulties of preparing materials of a high degree of purity and of maintaining that purity have now been largely surmounted, and progress is being made in the direction of overcoming the difficulties presented in the study of the alloys by thermal methods. For the Cutting Tools Research Committee, Mr. E. G. Herbert has studied and has presented a report on the hot-hardness characteristics of modern tool steels and alloys, and Professor Dempster Smith has completed an investigation into the cutting of brass with high-speed and carbon-steel tools. The Steam Nozzles Research Committee completed its work during the year. Its sixth and final report was presented at last Friday's meeting and is referred to below. At Woolwich Polytechnic Dr. W. A. Scoble, on behalf of the Wire Ropes Research Committee, tested three ropes of 2in. circumference. The results of this and other tests have been embodied in a fourth report, which is to be discussed in writing. Researches in which the Institution is interested have been conducted in certain university laboratories. Among them are an investigation into the creep of metals at ordinary and high temperatures, and experiments on the distribution of stresses in cams and worm gearing.

On the financial side the report showed that during the year the income of the Institution amounted to £37,891, and its expenditure to £37,287.

Following the adoption of the report, Dr. Adamson announced that Mr. L. St. L. Pendred had been elected President for the ensuing year; that Prof. W. E. Dalby and Mr. Charles Day had been elected vice-presidents, and that Sir John Thornycroft, Mr. Sterry B. Freeman, Mr. R. E. L. Maunsell, Professor F. C. Lea, Mr. Cecil Bentham, Mr. W. A. Stanier and Mr. J. F. Petree had been elected members of Council. Dr. Adamson also announced that the Council had elected Dr. H. S. Hele-Shaw and Baron Shiba, of Tokio, as honorary life members.

Mr. Pendred having taken the chair, Dr. Telford Petrie was called upon to present the sixth and final report of the Steam Nozzles Reasearch Committee. The Committee's first and second reports were presented in 1923, the third in 1924, the fourth in 1925 and the fifth in 1928. The sixth report summarises all the previous work and contains the results of some tests carried out since 1928. We give below a short account of it.

STEAM NOZZLES RESEARCH.

The work of the Committee has consisted, for the main part, in a series of measurements of the efficiencies of many and various forms of steam nozzle, carried out with a view to the determination of the efficiency values to be expected in certain representative types, both of straight and curved nozzles, and the investigation of the changes in efficiency which accompany certain specific variations in the shape and size of the nozzle and in the condition of the steam passing through it.

A form of testing apparatus has been devised and constructed which has shown itself to be capable of giving reliable and reasonably accurate measurements of the efficiency of any usual form of steam nozzle over a range of steam speeds from 300ft. to 2000ft. per second, and which is therefore suitable for general use in the very wide field of nozzle testing. Special attention has been paid in these tests to the more practical forms of nozzle.

Quite apart from the original intention of efficiency testing, a subsidiary departure into efflux angle measurement undertaken first of all as a necessary adjunct to the main research, yielded results of sufficient importance to justify its consideration as a separate line of investigation. The results obtained in this field, while they have not been pursued as far as their practical interest would warrant, have revealed important facts in regard to the phenomena of stability of operation and variability of discharge angle in the flow of steam through nozzles.

The tests of various types of impulse and reaction nozzles have shown that there is no serious diminution of efficiency as the steam speed is reduced. On the contrary, there is in many cases a considerable improvement at speeds of less than about 600ft. per second. The knowledge that there is no inherent disadvantage in the use of low steam speeds in nozzles has doubtless been one of the factors contributing to the general reduction of the steam speeds to be found in recent turbine practice.

The effects of varying throat length, discharge angle and plate thickness have been investigated for impulse nozzles of the cast-in plate type. The use of long throats is detrimental to the efficient functioning of nozzles. The effect of throat length is apparently connected with the discharge angle of the nozzle, being much more pronounced in 20 deg. nozzles than in those of 12 deg. angle. The use of thick division plates produces an appreciable percentage decrease in the efficiency, but this disadvantage may be overcome almost entirely by suitable chamfering of the plates at the downstream edges. In 0/1 throat nozzles with thin or suitably chamfered thick plates there appears to be little difference in efficiency, on the average, between nozzles of 20 deg. and 12 deg. discharge angle. With long throats, however, the 20 deg. nozzles are considerably the more efficient.

The presence of solid surfaces in any position in the immediate neighbourhood of the steam jet, where they may impede the circulation of the steam between the nozzle and the impulse plate, has been shown to have an adverse effect upon both the stability of operation and the apparent efficiency of nozzles. It is therefore advisable to remove as far as possible any extraneous material from the vicinity of the jet and to allow it to issue in as free and unobstructed a manner as possible. Where steam emerges from two or more channels in close proximity it appears essential, for the highest efficiency, that the openings on the down-stream side of the nozzles should be close together and separated only by a fine edge of metal. Otherwise a region of reduced pressure is formed between the jets, which is a cause of instability and deviation in the direction of the jets, and of an additional and unnecessary loss of energy.

In an interesting digression from the main programme arising from a desire to compare curved practical nozzles with others of more simple shape, tests have been carried out upon a number of straight nozzles of various kinds. These tests gave efficiency values superior to those of the curved nozzles, and further research into the parts played by surface roughness, entry conditions, and channel curvature has followed naturally upon them. Tests of straight nozzles with artificially-roughened surfaces indicated a loss of efficiency of up to 6 per cent. in the worst cases from this cause. A comparison of two geometrically similar nozzles, of ¼in. and 1¼in. diameter respectively, showed no appreciable difference in velocity coefficient. A series of convergent nozzles of constant length and throat area, but with differing shapes of cross section, gave energy efficiencies of the order of 98 per cent., and showed that, in nozzles of this type, the efficiency is hardly affected by the shape of cross section. With parallel-side nozzles having a sharp corner of entrance, however, there was a difference of efficiency in favour of the nozzles of least perimeter.

To determine whether the results of the tests, which are normally made with the nozzles discharging into a space where the pressure is approximately atmospheric, could be considered as applying equally to other pressure conditions, a number of nozzles have been tested with a back pressure of 60 lb. per square inch absolute, or four times the usual value. Though the accuracy of the testing was somewhat reduced under the changed conditions, the large alteration in pressure should have been sufficient to bring into prominence any marked tendency of the efficiency to vary in accordance with the steam pressure. No change in the efficiency could, however, be detected, and it was concluded that the rate of change of efficiency with alteration of steam pressure must be very small.

Three nozzles have been tested under varying conditions of steam temperature. In two cases an increase of temperature of an average value of about 30 deg. Cent. decreased the efficiencies, more particularly at low values of the steam speed. In the third case an increase of about 130 deg. Cent. gave an increase of efficiency at the higher speeds only. Though the effect is by no means negligible, and is not as yet completely understood, it appears from these tests that any alteration of efficiency with steam temperature is not sufficiently great to affect to any large extent the amount of the gain which is known to be obtainable from the use of high-temperature steam in turbines, as the result of considerations other than that of nozzle efficiency.

The efficiency of a curved nozzle is also dependent upon the value of the radius of curvature of the mean path of the steam; the effect of increasing the radius being to raise the efficiency over the range of speed which would normally be employed in such nozzles. The amount of the improvement is not constant, but depends on other factors, being least for a large-angle long-throat nozzle and greatest with short throat length and small discharge angle. In the nozzles tested, which had cast-in division plates of uniform thickness, the average increase in velocity coefficient brought about by doubling the radius of curvature of the plates was a little less than 1 per cent.

The manner in which the steam approaches and enters the nozzle appears to be of considerable importance as regards the reduction of energy loss. In this connection the effect of removing sharp edges at the entrance to nozzles has been studied for both straight and curved forms. In the former, improvements of up to 20 per cent. in the efficiency were found when the entrance corner was rounded off in the form of a circular arc of ⅛in. radius. The increase of efficiency resulting from the rounding of the corners at the sides of the entrance to a 20 deg. curved nozzle to a radius of ⅛in. was about 1 per cent. In a 12 deg. curved nozzle the improvement was so small that it could not be detected. Tests on the effect of roughened, as compared with smooth, radiused entries to straight nozzles have indicated a reduction of the velocity coefficient of about 1 per cent. in cases where the roughness in the bore of the nozzle is not too pronounced. In cases where the bore is exceedingly rough the conditions of entry are overshadowed, so far as roughness is concerned. The importance of

good entrance conditions is definitely established, both in straight and curved nozzles as a feature of great moment in efficient nozzle flow.

These tests of steam-nozzle efficiency have demonstrated the utility and reliability of the impulse method of testing, and have shown that, by its use, results of practical value in the design of steam turbines may be obtained. The Committee has seen with growing satisfaction the adoption by many turbine manufacturers, in this country and elsewhere, of the type of apparatus which was first developed for use in these experiments, and hopes to see a continuation of the work carried on by these investigators, by the further testing of individual types of nozzles, with a view to the development of yet more perfect forms than those which are now in use.

Mr. Pendred, in moving a vote of thanks to Dr. Petrie, referred briefly to the Institution's activities in the undertaking of research work. He recalled in particular the investigations on lubrication, alloys and marine oil engines in which it had assisted. Incidentally, he mentioned that the work of the Marine Oil Engines Committee was not concluded, and that another vessel had been offered for testing. None of these investigations, Mr. Pendred continued, had exceeded in direct usefulness the work of the Steam Nozzles Research Committee. That Committee might for the time being have concluded its labours, but, if necessary, it would reopen its investigations in any direction that might appear desirable.

Mr. I. V. Robinson, opening the discussion, dealt principally with the share taken in the Committee's work by the British Electrical and Allied Industries Research Association. From the outset it had borne with the Institution an equal share in the cost of the investigation. In the earlier years it had been asked if it were satisfied with the results which were being obtained. It replied that so satisfied was it that if the Institution should choose to give up the work the Association would continue it at its sole charge. The design of turbines had been substantially modified as an outcome of the Committee's research results. Those results showed that it was not necessary to run the blades at as high a speed at the high-pressure end as was once thought to be essential. The reduction of speed had produced a very great saving in coal consumption. The saving achieved could be seen in the figures given in the Electricity Commissioners' reports for the past five years or so. He thought that the Committee's work should be continued in its details by individual firms and that if further collective research were required, the Committee should be asked to undertake it.

Mr. H. L. Guy described very briefly the results of some tests on the efficiency of steam nozzles which his firm, the Metropolitan-Vickers Electrical Company, had recently carried out. He pointed out that the results arrived at by the Committee showed in actual fact the *average* efficiency across the whole of the nozzle exit orifice. The Experimental Department of his company had gone a step further and examined the distribution of efficiency across the nozzle stream. The results could best be appreciated by means of a solid model, of which Fig. 1 represented an elevation and a plan. Fig. 2 was a contour diagram showing lines of equal energy loss. In the corners of the boundaries the losses reached values as high as 70 per cent., but at the centre of the nozzle there was a core of considerable magnitude in which the efficiency was almost 100 per cent. The serious losses in the nozzle were distributed very locally. It was to be noted that a considerable proportion of the steam discharged from the nozzle with apparently an efficiency of 100 per cent. had passed through the entry and round the corner of the nozzle, and had therefore been subjected to the influence of the two factors which were usually associated with the losses in a nozzle. It seemed impossible that the high efficiency core could receive a contribution of energy from the slower moving portions round the boundaries, in which most of the losses appeared to occur. It therefore would seem that the most serious source of loss might be associated with the boundary layer. He added that on integrating the efficiency over the cross section of the nozzles, a figure was obtained which agreed within one-fifth of 1 per cent. with the average efficiency figure as determined by means of a duplicate of the Committee's testing device.

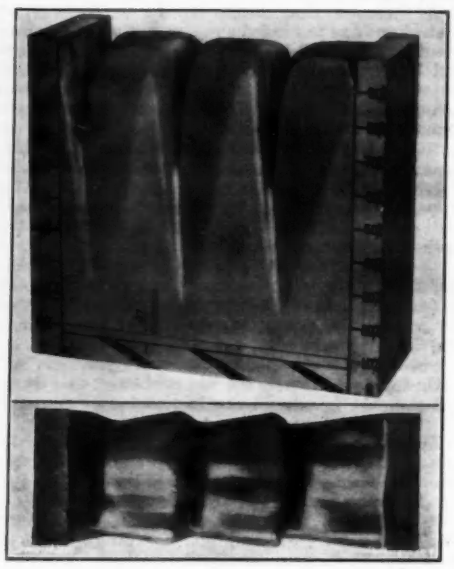


FIG. 1—ELEVATION AND PLAN VIEW OF MODEL

Professor G. G. Stoney made a fitting reference to the late Professor Callendar, without whose work the Committee's investigations would, he said, have been impossible. He also paid a tribute to Mr. H. M. Martin, who was responsible for the design of the original testing device used by the Committee. According to Mr. K. Baumann the efficiency of turbines had been increased by 10 per cent. during the past ten years, and a large part of that increase could be ascribed to the work done by the Committee. The saving of coal represented by that increase was very great compared with the cost of the research. Many of the Committee's results now seemed obvious to us, but, nevertheless, they took several years and much hard work to establish.

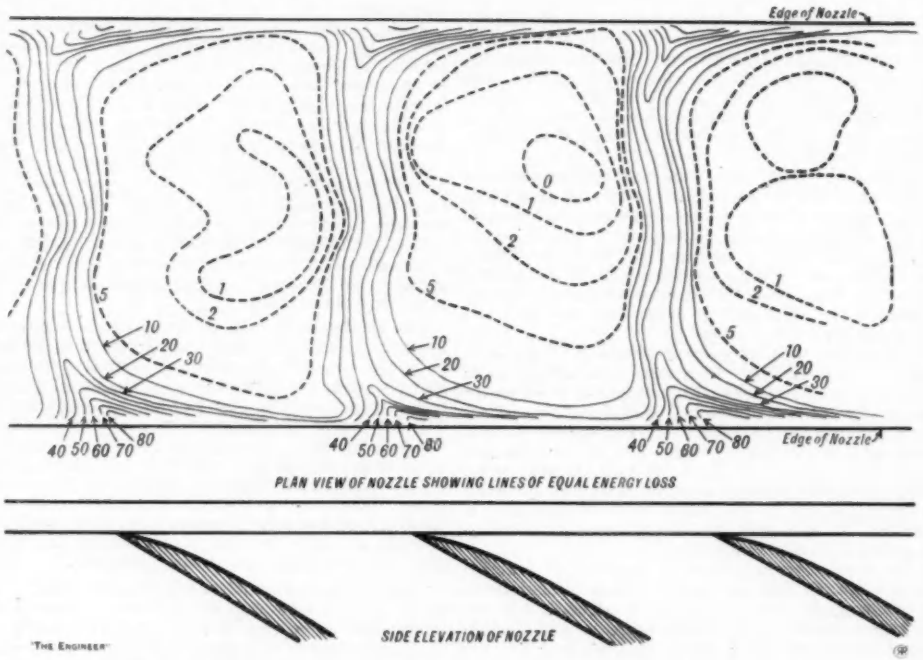


FIG. 2—CONTOUR DIAGRAM SHOWING LINES OF EQUAL ENERGY LOSS

Mr. A. J. Fitt, while acknowledging the debt which turbine builders owed to the Committee, expressed regret that the effect of the efflux angle and the phenomenon known as "flapping of the jet" had not been studied in greater detail. In turbines it was not always possible to work to a sharp edge so as to avoid the formation of "lands" in the neighbourhood of the jet exits, the cause of flapping. In practice the inlet edge of the blades was chamfered. The Committee had, however, only studied the effect of chamfering the outlet edges. He suggested that if the inlet edges had been chamfered the differences recorded by the Committee between thick and thin plate nozzles might have disappeared or been reduced.

Dr. A. P. Thurston dealt with the boundary layer and its effect on the efficiency of the jet passing through the nozzle, and suggested means whereby the efficiency of the jet might be improved by modifying the boundary layer conditions.

Dr. Petrie devolved the reply to the discussion on Mr. W. H. Patchell as chairman of the Committee. Mr. Patchell hoped that others would carry on the Committee's work. He expressed the Institution's appreciation of the assistance which had been rendered by the British Electrical and Allied Industries Research Association. Originally, the Association had reserved the right to withhold any results the publication of which might not be to its advantage. At no time throughout the work of the Committee had that right been exercised. Nothing had been suppressed, even although turbine builders outside the Association were to benefit by publication. Mr. Patchell concluded with an expression of the loss which the Committee had sustained by the death of Capt. H. R. Sankey, the original chairman, and recently by the death of Professor Callendar. To Mr. H. M. Martin he expressed the Committee's appreciation of the work he had done in designing the testing appliance used throughout the research and now in use by many firms which were conducting their own nozzle experiments.

Charing Cross and Waterloo Bridges and the London County Council.

AT its meeting of Tuesday last the London County Council had before it a Report of its Parliamentary Committee regarding the Council's Charing Cross Bridge Bill. As this Report gives an excellent summary of the position of affairs in connection with both Charing Cross and Waterloo Bridges, we reprint, in what follows, the major portion of it.

REPORT OF THE PARLIAMENTARY COMMITTEE.

6th and 20th February, 1930.

LONDON COUNTY COUNCIL (CHARING CROSS BRIDGE) BILL —SECOND READING.

1.—The London County Council (Charing Cross Bridge) Bill came up for second reading in the House of Commons on 19th February, 1930.

It has been represented to us that the case on behalf of the scheme embodied in the Council's Bill has not been fully put before the public. We take the opportunity, therefore, of summarising the case, most of which was put in the debate on second reading by those who had kindly undertaken to back the Bill :—

1.—A new bridge at Charing Cross has for many years been a subject of discussion, but the present proposal arises out of the report of the Royal Commission on Cross-River Traffic in London (1926). This Royal Commission was appointed owing to the failure of certain of the arches of Waterloo Bridge and to the controversy which arose as to whether that bridge should be reconstructed or should be entirely demolished and a new bridge built, and recommended that the bridge should be reconstructed and widened to take four lines of vehicular traffic. The Council had decided that the bridge should be rebuilt to take six lines of traffic, but the Royal Commission stated that they did not think it either necessary or desirable that a bridge of such dimensions should be erected at this spot and that the demand of through-London traffic could be far better satisfied by a new bridge at Charing Cross. In thus linking up their proposals for Waterloo and Charing Cross bridges it is clear that the Royal Commission regarded their proposal for a restricted widening of the former bridge as practicable only if a road bridge were built at Charing Cross at a date earlier than was previously contemplated. On this latter point they remarked :—

> "Apart from the weighty evidence which we have received in its favour, we are ourselves convinced that, in the interests of traffic, a new road bridge at this point (Charing Cross) is essential. We regard its provision as of special importance as a means of affording relief to both Waterloo and Westminster bridges, and we are of opinion that there should be no unnecessary delay in proceeding with this project."

2.—The Royal Commission considered many schemes for the suggested new bridge and their definite recommendations on this subject involved the removal of the railway station to another site slightly to the east of the present site, the demolition of the existing railway bridge and the construction of a new double-deck bridge to accommodate railway, vehicular and pedestrian traffic, with a viaduct over the Strand and extensive approaches to the bridge from both sides of the river.

3.—The Council on 29th March, 1927, decided to give effect to the recommendations of the Royal Commission as to Waterloo Bridge, provided that the necessary steps were taken to construct a bridge and approaches at Charing Cross in accordance with a scheme to be approved by H.M. Government and the Council, subject to agreement as to the amount of grant to be received from the Government.

4.—The Ministry of Transport instituted an inquiry into the financial, engineering and other aspects of the scheme suggested by the Royal Commission, and Messrs. Mott, Hay and Anderson, consulting engineers, and the Council's Chief Engineer, were appointed to investigate the matter and draw up a report. After close examination, the engineers found that the carrying out in all its details of the recommendation of the Royal Commission presented serious constructional difficulties which, though not insuperable,

led them to suggest the transfer of the railway terminus to a site at Waterloo Junction, thus obviating the necessity for providing accommodation for railway traffic across the river.

5.—The attitude of the Southern Railway Company throughout has been that any scheme involving removal of their terminal station to the Lambeth side of the river would possess disadvantages from various points of view, but that they would not resist such removal if the Government were satisfied that the provision of an additional bridge over the river was a matter of national necessity and that the removal of the station was vital to any such scheme. The company, however, raised serious objections to the transfer of the station to the site selected by the engineers. As a result of further examination, the conclusion was reached by all parties that the present proposed site, which is the only practicable alternative on the Lambeth side to the site at Waterloo Junction, had great advantages. It is considerably nearer to the existing Charing Cross Station and is in such a position that connections can much more easily and conveniently be formed with the three underground railways at Waterloo. This position for the new station received the general approval of the Council on 31st July, 1928, subject to satisfactory terms being arranged with the Southern Railway Company.

6.—Further negotiations then took place with that company, and these eventually resulted in the adoption by both the Council and the proprietors of the company of the heads of agreement set out in the Seventh Schedule to the Bill, and the Council on 30th July, 1929, approved the general layout of the improvement and decided to promote the necessary legislation.

7.—There have also been negotiations with the London Electric Railway Company and the Metropolitan District Railway Company with a view to powers (which are included in the Bill) being obtained to enable those companies to carry out works which will greatly increase the facilities for the travelling public.

8.—The Bill, if passed, will involve the demolition of the existing railway bridge, which the Royal Commission described as "an eyesore and a blot on one of the finest vistas in Europe."

9.—It is not practicable to construct a "bank-to-bank" bridge without materially raising the existing bank level, as, apart from other important considerations including traffic, the bridge must be constructed at such a height as not unreasonably to restrict the use of the river for navigation purposes. The height of the bridge and the level of the railway necessarily involve the construction of roads carried at a high level and such roads have to be continued until they can connect up with appropriate traffic centres. The scheme in the Bill involves considerably less viaduct construction than was entailed in the scheme recommended by the Royal Commission and has been devised with full regard to the important traffic problems involved. Every scheme suggested during the last thirty years was most carefully examined before the present proposals were settled.

10.—The primary considerations involved are finance, traffic, engineering, valuation and architecture, and the best advice has been obtained under each of these heads.

11.—The scheme, which has been prepared in collaboration with the Ministry of Transport, deals in a comprehensive manner with the whole of the transport problem, and it is believed that the improved facilities for an easy flow of traffic on to and off the bridge and for the interchange of passenger traffic as between railways, tubes, omnibuses and tramways, coupled with the removal of the present unsightly bridge, will fully justify the expenditure involved. It should be remembered that the scheme is mainly one for the construction of the bridge over the river Thames, the siting of which has to be considered in relation to the requirements of navigation of the river, to the site of the new station and to the presence of underground railways, and for the making of road connections in the immediate neighbourhood. The scheme will not, however, interfere with the solution of other traffic difficulties, and has been designed in relation to other improvement schemes now in contemplation, *e.g.*, at the Elephant and Castle and Vauxhall Cross. Consideration is also being given to the question of the improvement of the traffic facilities north of the Nurse Cavell statue.

12.—As regards cost, the necessity for keeping the expenditure within reasonable limits has to be borne in mind. The Council has heavy liabilities to face in connection with the reconditioning of Waterloo Bridge and other important improvement schemes. So far as the Council is concerned, the net cost of the scheme for which authority is sought in the Bill is £12,500,000; 75 per cent. of this cost is to be borne by the Road Fund, but there are many other calls upon that Fund. It is submitted that it would be impracticable to devise a less expensive scheme which would secure the improved traffic facilities provided by the present proposals and be equally effective in dealing with the many other problems involved. Any suggestion to place the terminal station of the Southern Railway underground is impracticable because the cost would be prohibitive.

13.—The layout of the present scheme has been drawn up in collaboration with Sir Edwin Lutyens, R.A., whose services were secured by the Minister of Transport.

14.—Ornamental gardens and a river embankment extending from the County Hall to Waterloo Bridge will be provided on the Lambeth side as part of the development of this area.

15.—Within the limits of the present proposals the Council has been willing to consider any suggestions for the best possible architectural treatment of the scheme, and if the present Bill becomes law, to throw open to competition the designs of the main features of the scheme, including the new bridge and viaducts and the circuses in the Strand and in Waterloo-road.

16.—As has been stated above, the question of a new bridge is linked up with that of the reconstruction and widening of Waterloo Bridge. The rejection of the scheme, after lengthy and difficult negotiations have been brought to a satisfactory conclusion, might cause the indefinite postponement of the proposal to construct a new bridge at Charing Cross, with the result that the problem of Waterloo Bridge would have to be reopened.

Notice of motion for the rejection of the Bill had been given by Sir Martin Conway, but, in his absence at the commencement of the debate, the motion was moved by Sir William Davison. The speakers supporting the Bill on behalf of the Council were Sir Walter Greaves-Lord, K.C., Sir Kenyon Vaughan-Morgan and Mr. John Scurr. Colonel Ashley, the Minister of Transport in the late Government, and the present Minister of Transport also strongly supported the Bill. On a division the Bill was read a second time, 230 voting in favour and 62 against.

During the debate Mr. Strauss referred to the question of the rehousing of some 5000 persons of the working class who will be displaced if the scheme is carried out. As regards this, we would point out that the Council is under statutory obligation to rehouse these people, that arrangements have already been made whereby about 1000 persons will be accommodated in the borough of Lambeth, and that it is the Council's explicit aim to secure suitable sites to provide accommodation for the remainder within a reasonable distance of their residence or place of employment.

The following motion by Mr. Harris was agreed to by the House:—"That it be an instruction to the Committee on the Bill to insert clauses or obtain an undertaking from the promoters to secure by competition, or otherwise, designs for the bridge and for the architectural treatment of the viaducts." We propose to consider, in consultation with the Improvements Committee, as to the terms of a draft clause or an undertaking to be offered when the Bill is before the Select Committee of the House.

The Bedford Rural Electrification Scheme.

In our last issue brief reference was made to the Bedford rural electrification scheme, which has been designed to serve as a local demonstration of the advantages of rural electrification and of the possibility of more rapid development than has hitherto been regarded as economically possible. As we explained, the area is 101 square miles in extent, with a population based on the 1921 Census of 15,860 and 4038 occupied dwellings. The average density of the population is thus 157 per square mile, or practically the same as the general average of 151 per square mile for all rural areas in England and Wales. A small additional part of the authorised area about Maulden and Clophill has been included, but does not merit special reference. About three-quarters of the land is cultivated, a large proportion being devoted to corn raising, whilst the remainder is largely pasture land. The area contains two brickworks, which are already connected to the Corporation's system, and other industries may take supplies in due course. Public supplies of gas are available only in three villages, namely, Aspley Guise, Goldington and Turvey.

The technical scheme for the development of the demonstration area is based upon a supply of electricity in bulk obtained from Bedford, which occupies a fairly central position in relation to the area and is a "grid" point under the South-East England electricity scheme. It involves the construction in the main area of a network of about 56 miles of three-phase, 11,000-volt overhead transmission lines, and in completing the circuit use will be made of about 7 miles of existing underground cable which runs from Bedford to Sandy and also of one or two other existing lines. Smaller villages, isolated residences, and farms are to be supplied from single-phase extensions, representing a further 87 miles of 11,000-volt overhead lines. The transmission pressure at Bedford has hitherto been 6600 volts, but provision has been made in the scheme for stepping up to 11,000 volts at four transforming points, namely, Wootton, Pillinge, Harrowden, Bromham and Milton Ernest. Either brick-built sub-stations or kiosks of simple design will be provided at these points, and in three cases the transformer equipment will have a capacity of 500 kVA and in the fourth case a capacity of 200 kVA. Supplies to villages and isolated consumers will be given by pole transformers, which in the case of three-phase supplies will have capacities of 50, 20, and 10 kVA, and in the case of single-phase supplies 20, 10, and 5 kVA. For low-tension distribution in villages involving about 45 miles of lines it is anticipated that in most cases a neat overhead system which does not interfere with the amenities will prove possible, but a margin has been allowed in the estimates in case a certain amount of underground distribution should prove desirable in some instances. The distribution pressure is to be 400/230 volts.

It is contemplated that the whole of the transmission system will be constructed within two years, the first of which has been designated "Constructional Year." Thereafter the only additional capital expenditure will be that incurred in connecting new consumers. The total capital cost for the main area, including all service connections and meters on consumers' premises, is estimated to be £116,250. This figure, which is based upon the use of cadmium-copper and steel conductors for the overhead line system, affords a margin for reduction; and it is believed that by careful attention to detail and by the use of the most economical materials for the overhead system a saving on this estimate will prove possible in practice. No provision has been made in the estimates for capital expenditure in connection with the provision of assisted-wiring and of apparatus on hire or hire-purchase, as the nature of the facilities to be offered for these purposes has not been settled. In so far as the assisted-wiring and hire facilities are not self-supporting, the estimated financial results of operation would be adversely affected to that extent.

With intensive development assisted by various factors, such as the offer of supplies at reasonable rates and facilities for assisted-wiring and the hire or hire-purchase of electrical apparatus, coupled with active propaganda, it is estimated that by the end of six years from the commencement of supply about 75 per cent. of all the dwellings in the demonstration area will be connected to the supply system, and that the sales of electricity will have grown by that year to an average of about 130 units per head of population in the area, or 700 units per connection. The estimates of revenue are based upon the assumed adoption of an attractive two-part tariff for domestic supplies, and of suitable alternative flat rates for consumers taking supplies for lighting and/or power only. These charges are estimated to yield an average revenue from all classes of supply taken collectively of 2·4d. per unit sold, this being considered a reasonable figure under the assumed conditions of development. By the sixth year the revenue from dwellings and farms will thus be equivalent to an average of £1·3 per head of population, or £7 per connection. The annual growth in the number of connections and of revenue is estimated as follows for the main demonstration area:—

Year of working.	1st.	2nd.	3rd.	4th.	5th.	6th.
Estimated number of connections at beginning of year ..	808	1,655	2,221	2,624	2,907	3,028
Estimated total units sold, thousands	870	1,380	1,720	1,940	2,080	2,110
Units sold per head of population	55	87	108	122	131	133
Estimated total revenue, £	8,700	13,800	17,200	19,400	20,800	21,100

In arriving at the foregoing particulars for output and revenue, due regard has been given to records of revenue and sales in rural areas where development has already taken place and to records of the consumptions of individual consumers in rural areas where electricity is used for lighting, cooking and heating.

As concerns the estimated expenses, the cost of current per unit delivered to the system of the demonstration area has been taken on the basis of a two-part charge giving an average of 0·85d. per unit at the outset, decreasing thereafter to an average of 0·55d. per unit in the sixth year of operation. In the earlier years substantial allowances have been made for canvassing and advertising expenses; but after the fifth year of operation no such provision is made, as with the degree of development then attained the question of the extent to which further expenditure should be incurred for these purposes would call for review. Adequate provision has been included for repairs and maintenance of the system, for rents, rates and taxes, wayleaves, meter reading, costs of a car, a proportion of the costs of a sales engineer and general management expenses. In the net revenue account, interest has been charged at 5 per cent. and sinking fund payments are taken as accumulating at 3½ per cent. In respect of certain items of capital expenditure, such as transmission lines, not productive of full revenue in the initial years, provision has been made for the suspension of sinking fund payments for five years. After providing for interest on bank overdraft—revenue account—the estimates show deficits on net revenue account in the constructional year and the first two years of operation, but surpluses in each of the years thereafter; such surpluses being sufficient to place the scheme on a remunerative basis in the course of a few years of working.

The Corporation of Bedford agreed to co-operate in carrying out the demonstration rural supply scheme subject to being given some financial guarantee in view of the uncertainty involved in a project which was not estimated to become self-supporting until after the lapse of a few years. As the outcome of an application made by the Corporation under the Development and Road Improvement Funds Act, 1909, the Treasury agreed to make advances to the Corporation from the Development Fund during a period not exceeding ten years of such sums, not exceeding £8000, as might be required to meet 75 per cent. of the actual annual deficits, if any, on the working of the scheme, such advances to be subsequently repayable out of surpluses. This assistance was given by the Treasury on condition that the scheme should be subject to the general surveillance of the Electricity Commissioners, and on the understanding that the advice and assistance of the Commissioners would be available to the Corporation, and that the Development Commissioners and other interested Government Departments should be kept in touch with the development of the scheme. Separate accounts are to be kept by the Corporation in respect of the demonstration scheme in a form to be approved by the Electricity Commissioners.

The preliminary plans for the layout of the transmission system have been approved and the final plans and specifications have now been prepared. The task of obtaining wayleaves is already in hand. A suitable scheme of propaganda is to be carried out by the British Electrical Development Association, subject to the general approval of the Bedford Corporation. A sales engineer and cost accountant for the whole of the Bedford area of supply have been appointed by the Corporation, and premises for a town showroom have been acquired. The questions of a suitable two-part tariff for the demonstration area and of suitable schemes for assisted-wiring and the hire or hire-purchase of apparatus are now under consideration, and the proposals of the Corporation on these matters will be reviewed by the Electricity Commissioners. Supplies which will be included in the scheme are already being given in the ten parishes. It is anticipated that a supply will be available during the summer of 1930 in other parts of the demonstration area, and by the early part of 1931 in the whole of the area.

Many little details that are of interest to most readers as to the Great Western Railway were revealed in a lecture on "The Work of the Engineering Department," given on January 30th before the G.W.R. (London) Lecture and Debating Society by Mr. E. G. Matheson, the Assistant Chief Engineer to the Great Western. Owing to axle-loading limitations certain locomotives were not allowed on particular branches; these restrictions were indicated by different coloured discs on the side of the locomotives. There are 1675 passenger and goods stations, and the 167 tunnels were of a total length of 60 miles. For the inspection of Box tunnel, the roof of which is, in parts, 40ft. above rail level, a 60-ton crane is fitted with a crow's nest which is capable of carrying four or five men and of being raised and lowered as required. All the other tunnels are inspected regularly by means of a special, suitably fitted brake van.

The Relative Safety of Mild and High-tensile Alloy Steels under Alternating and Pulsating Stresses.*

By BERNARD P. HAIGH, D.Sc.

Introduction.

It is well known that metal parts of structures and machines are liable to fracture in service after repeated application or reversal of moderate loads—often much smaller than have been applied in brief overload or overspeed runs. Such "fatigue" fractures exhibit a characteristically brittle appearance as if the metal were unable to avail itself of whatever ductility it may be able to show in ordinary tensile, bending or other mechanical tests. The face of the fracture is often nearly flat, with shell-like markings that indicate the manner of its gradual growth.

Fig. 1 shows the appearance of a typical fatigue fracture in a "Wöhler" test piece subject to bending. After several million revolutions with a stress well below the yield point, this test piece of "30-ton" mild steel suddenly cracked and thereby automatically stopped the testing machine. At this stage, the crack could be seen only as a fine hair line round half the circumference of the bar. The piece was afterwards gripped in a vice and bent by hand to open the crack. The original crack is now seen to cover

FIG. 1—TYPICAL FATIGUE FRACTURE

about half the cross section. The second part of the fracture, formed during the subsequent plastic bending by hand, has quite a different appearance—much like that of an Izod notched bar fracture. In an ordinary "static" bending test with a much greater load, this ductile steel would have bent through 180 deg. without any sign of cracking.

Mechanical fatigue may be defined as a change that occurs in metals during oft-repeated application or reversal or other variation of stress, and results eventually in the formation of cracks when the range of stress is sufficient.

Different authorities have stated that 90 per cent. of the fractures that result in breakdowns in service are attributable to fatigue, and although this proportion may perhaps be overstated, there can be no real doubt that fatigue cracking is to-day one of the more common causes of fracture in service.

It is proposed to review and discuss a wide variety of tests and experiments with alternating and pulsating stresses, to illustrate the conditions in which fatigue may be a source of danger, and to contrast the conditions for different kinds of steel. It will be shown that the relation between the fatigue strength and plastic yield strength in mild steel is such that fatigue is necessarily uncommon in that metal in practical experience with ordinary conditions of loading.

As the use of alloy steels is now firmly established in automobile engineering—with exceedingly beneficial results—the advantages and dangers associated with such steels deserve careful consideration. The standard scantlings and factors of safety in general use to-day for alloy steels are based in some degree upon experience gained in the use of mild steel, which has proved itself one of the most reliable of metals and a very good friend to the shipbuilder and the engineer. It should not hastily be assumed that the same scantlings and factors are necessarily suitable when the steel used is of a widely different type.

The advantages gained by the use of alloy steels result in the main from reductions of weight consequent upon the use of smaller and lighter parts. One of the more important dangers is that such smaller parts, of equal or greater static strength, as judged by calculation or by actual tests, may be more liable to fracture under the action of fatigue.

It is not intended to suggest that all high-tensile alloy steels are necessarily subject to the dangers that will be discussed. On the contrary, some appear to excel—when suitably heat treated—in the very qualities that have proved themselves so beneficial in mild steel. The immediate object of this paper is therefore to present a simple but scientific basis for the comparison of different steels, as regards their relative liability to fracture from fatigue.

Endurance and Fatigue.

In laboratory tests for fatigue, the load on the test piece is varied automatically in a cyclic manner—between known extreme values that are repeated during each "cycle" of stress. The "endurance" of the test piece is defined as the number of cycles required to cause fracture when the range of stress is maintained constant throughout the continuance of the test.

To investigate fatigue in any particular sample of metal, it is customary to test about half a dozen identical pieces with different ranges of stress, and to record the different endurances.

Fig. 2 shows the results obtained in a typical series of tests carried out in this way. The ranges of stress are plotted against the endurances on a uniform scale or on a logarithmic scale as may be preferred. The graphs indicate how the endurance increases rapidly when the range of stress is reduced towards a limiting value, below which the metal is apparently immune from fatigue.

The "fatigue limit" of a material is defined as the greatest stress that can be applied and reversed continually without eventually causing fracture; or, if the cycle of loading is between unequal extreme values of stress, then the definition may be modified to read "half the limiting range of stress."

It is unfortunate that it is not possible, from the results of a few brief tests with high ranges of stress, to anticipate the limiting range that will just break a test piece after very great endurance. In different metals, the tests have to be continued to different endurances to find the value of the fatigue limit; but in steels, the lengths of run required do not differ as widely as in some other metals. It was formerly held that an endurance of 1,000,000 cycles was sufficient to give a close approximation to the fatigue limit, but endurances up to 5,000,000, or even 10,000,000 are now generally regarded as desirable to indicate the value more exactly.

Unless the frequency of reversal—measured in stress cycles per minute—is much higher than the rates in general use, either in practice or in testing, the value of the fatigue limit appears to be quite independent of the frequency. There seems to be no ground for the old idea that higher frequency is in itself more dangerous when the range of stress is the same. The practical danger associated with higher speeds appears to be due simply to the higher stresses with which they are often associated.

The higher the frequency used in testing, the shorter is the total time required to ascertain the value of the fatigue limit, but the time required is necessarily considerable, because unduly high frequencies often cause considerable hysteretic heating, especially in large test pieces, and the rise of temperature and gradient of temperature may then invalidate the tests.

The expense and time required for carrying out fatigue tests have led many investigators to seek for means of

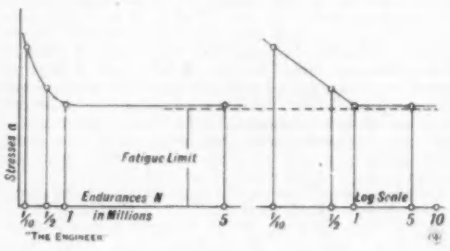


FIG. 2—RANGE OF STRESS AND ENDURANCE

anticipating the results of long continued tests. In particular, the heating and extension or bending of the test pieces have been studied with this end in view, but so far as the author is aware, no such means have proved reliable Of course, if a particular metal has already been investigated for fatigue, a single brief fatigue test may suffice to show that a repeat sample has similar qualities, and in a later section of this paper the author recommends a special form of test piece that offers advantages in circumstances such that a proving test of this sort may appear advisable.

The most important field for fatigue testing lies in practical research, in ascertaining the metals and heat treatments that may be most suitable for practical requirements, and in finding the most suitable forms for machine parts that will be subjected to specified conditions of loading. As a standard proving test for commercial use, the fatigue test cannot be recommended on account of the expense and time involved. Its chief service is to reduce as far as possible the number of costly lessons that otherwise may be taught by experience.

It is important to note that the endurance falls off rapidly with stresses that exceed the fatigue limit, and that the range corresponding to one million cycles is seldom much greater than the limiting range indicated by tests continued to much longer endurances. In an engine running at, say, 2000 revolutions per minute, an endurance of one million cycles corresponds to only 8½ hours' running—a short useful life even for a racing engine. For this reason the direct object of nearly all fatigue testing is to find the limiting "safe" range of stress.

In special circumstances, however, it may be serviceable to compare the endurances of different metals under stresses that considerably exceed the fatigue limit. Mr. A. T. Adam, of Musselburgh, has recently pointed out that wire ropes are commonly worked over pulleys, of which the diameters are such that the probable ranges of stress must greatly exceed the limiting safe values. In such ropes, however, the working life is commonly limited by abrasion or by corrosion, and as the frequency of passage over the pulleys is often very low indeed, high ranges of stress can be allowed for a time. When wire ropes vibrate with high frequencies, the importance of the fatigue limit is greater as long endurances accumulate more rapidly, and particularly when the vibration occurs under water, fatigue becomes evident under much smaller ranges of stress.

Naval architects commonly hold that the possibility of fatigue may be neglected in relation to the severe variations of stress caused by extreme storm conditions at sea, and they point out that, even if the period of waves is taken at only 10 seconds, an accumulated time of about 115 days of extreme conditions would be required to absorb an endurance of one million cycles. But the argument is probably misleading, because, if the incalculable range of stress is only slightly greater than that corresponding to one million cycles, the endurance of the metal may be greatly reduced. In the author's opinion, the fact that fatigue is seldom experienced in ship structures is chiefly due to another reason of greater significance. The mild steels that have long been in general use for ship structures are such that fatigue is almost always preceded by plastic strains that start the rivets and buckle the frames before cracking becomes probable. In such steels, it is only in exceptional circumstances—when the range of stress is between almost equal extreme values of pull and push—that cracking can precede plastic failure.

Methods of Measuring Fatigue Strength.

Machines of different types are used for carrying out fatigue tests, but only two of these, now in general use, will be here described. The Wöhler type of machine uses a rotating test piece that is loaded at one end and acts as a cantilever, while the Haigh machine uses a stationary test piece that is loaded in direct pull and push.

Fig. 3—top diagram—illustrates the form of one type of Wöhler test piece. The shank at the left is gripped in a revolving chuck fitted with adjusting screws that enable the operator to ensure that the test piece runs truly. The right-hand end of the test piece carries a ball bearing, from which a known load W is suspended. It is preferable to use a bearing with only a single row of balls in a deep groove, and to suspend the load on knife edges projecting from the housing that contains the outer ball race. The leverage of the load can then be measured accurately.

If fracture occurs through a section at distance L from the knife edges, the bending moment is W.L., and the range of alternating stress is given by—

$$2\,a = \pm(32\,.\,\text{W.L.}/\pi d^3),$$

where d is the diameter of the section that fractures. As this formula is valid only when the piece breaks at a section remote from a sharp shoulder, it is desirable to use a test piece with profile somewhat as sketched—tapered or well rounded—to ensure that the stress can be calculated with accuracy. The test piece breaks where the range of stress is greatest, and by applying the above formula, it is easy to show that this occurs where the profile touches a cone of which the apex lies at distance 3 L from the section of contact. To avoid vibration and consequent uncertainty in the range of stress, it is desirable that the motor that drives the machine should be well balanced, that the bearings should run smoothly on a large number of balls, and that the load should be suspended on a spring.

In all fatigue testing it is important that the surface of the test piece should be turned carefully and finished with fine emery or by grinding; even light scratches may appreciably reduce the fatigue strength. The condition of the surface is probably of special importance in Wöhler tests, because, in bending, the maximum range of stress is between equal values of pull and push, and occurs only on the surface. Below the surface the metal is stressed to lower values only, and although these parts affect the heating and deflexion of the test piece, they do not so directly determine the incidence of fracture.

Fig. 3 shows also the profiles of test pieces used in the Haigh machine—which acts by direct pull and push.

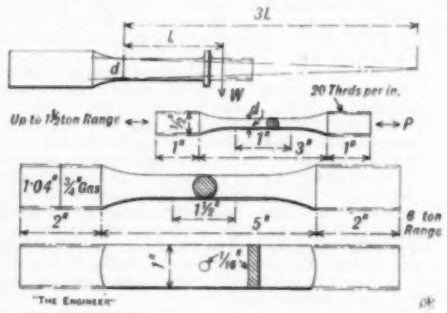


FIG. 3—WOHLER AND HAIGH TEST-PIECES

The standard pieces have cylindrical mid-parts with screwed ends and smooth transition curves. As in an ordinary tensile test, the alternating stress is the applied pull or push P divided by the cross-sectional area of the cylindrical portion—

$$a = \pm(\text{P}/0{\cdot}7854\,d^2).$$

It is interesting to note that in some metals large sizes of screwed ends are essential to ensure that fracture occurs in the cylindrical part of the test piece; in some cases, the screwed ends have to be nearly twice as large as the mid-part, or they may prove too weak. This is but one of many examples that illustrate the dangerous effect of the severe stress concentrations that are produced at sudden changes of section such as sharp shoulders or screw threads. It is found that different steels differ widely in their susceptibility to such stress concentrations, and that alternating stresses are often concentrated more than stresses that merely pulsate.

Two sizes of Haigh test piece are shown, suitable for different sizes of machine. The smaller size of machine is well adapted for tests of metallurgical character, while the larger is particularly designed for engineering tests for larger bodies of metal that can be machined to different shapes for investigating problems relative to stress concentrations, and for testing models and actual working parts. One of the larger pieces illustrated is of a form that is particularly suitable for practical tests, in which different metals are compared in their resistance to stress concentrations produced by pulsating loads. A piece is milled to a flat section which is pierced with a small round hole. Although the hole may reduce the section only very slightly, the consequent reduction in fatigue strength may be in ratio 2 : 1 or more in some cases, and only very slight in others.

Figs. 4 to 6 illustrate the general appearance and principle of the Haigh electro-magnetic fatigue testing machine. The test piece T stands vertically in an accessible position in the machine, its upper end being gripped in a holder that forms part of the head H. This head is carried on four

* Institution of Automobile Engineers, London, February 4th.

columns that rise from the foundation base B and carry two U-shaped laminated magnets that pull on opposite faces of the single armature A. The lower end of the test piece is connected to the armature by stout bars from the crosshead C, and these same bars are extended downward to a "compensating" spring S that is connected also to the base B.

The two magnets M_1 and M_2 are excited by two-phase currents from a small alternator that forms part of the equipment, but is not illustrated. Such alternating-current magnets act in quite a different way from the more familiar direct-current magnet. The pull of each rises and falls twice during each cycle of electric current, and the range of pull is almost independent of the width of the small air gaps between the magnets and the armature. The magnitude of the pull is, in fact, closely proportional

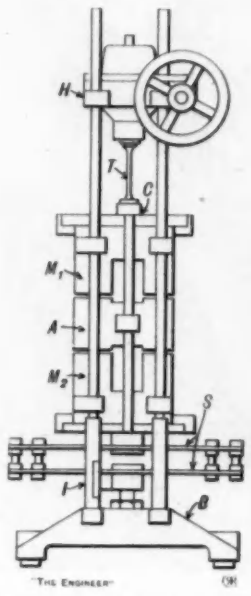


FIG. 4—HAIGH FATIGUE TESTING MACHINE

to the square of the quotient (Voltage/Frequency), and the range of load is adjusted by regulating the voltage supplied to the two coils wound round the poles of the magnets.

As two-phase currents are used for the two magnets, each, in turn, pulls its hardest when the other is exerting no pull. The combination of the two, acting on opposite sides of the same armature, produces an alternating force that varies between equal extremes in the two directions. To maintain a constant range of stress during the continuance of a fatigue test, it is only necessary to maintain a constant current in the field coils of the alternator that supplies the wattless currents required to excite the magnets. The power absorbed by the magnet circuits is

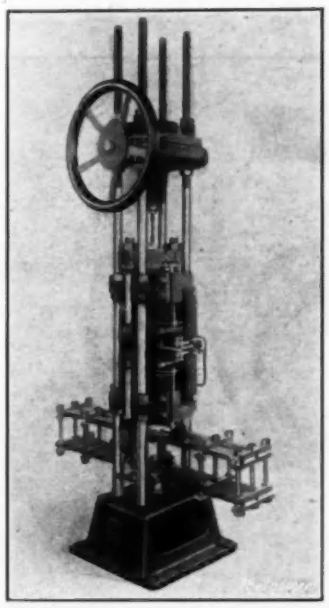


FIG. 5—1½-TON HAIGH MACHINE

only small, being that required to supply the iron and copper losses as in a transformer on no-load.

The pull of the magnets, transmitted to the test piece, is measured by a form of "voltmeter" arranged in a special manner, so that its readings depend directly on the quotient (Voltage/Frequency). This instrument indicates the range of stress directly—without separate readings of the two items. If the voltage and frequency change simultaneously in the same ratio, the reading of the instrument remains unchanged, as also does the range of stress in the machine.

The vibrating parts of the machine are guided by a pair of springs in the form of flat strips, located just above and below the magnets. It is important to note that this form of guidance ensures that the motion is vertical, i.e., in the direction of the length of the test piece. As a consequence, the test piece is free from any bending action—a matter of importance in relation to accuracy. Moreover, as no lubricated guides are used, no parts are subject to wear, and the operation of the machine is almost perfectly silent.

Bruntons, of Musselburgh, at present make two sizes of this machine, a smaller for a range of 1·5 ton and a larger for a range of 6 tons. As the base of the larger machine is mounted on springs, no large mass of concrete is required for its support. The general appearance of the smaller size is illustrated in Fig. 5. The larger model is shown in Fig. 6.

The two-phase currents that excite the two magnets are led through a special differential ammeter which serves to show when the currents in the two circuits are equal. At the start of any test, the hand wheel of the adjusting head is turned so that the ammeter indicates balance, showing that the armature vibrates mid-way between the two magnets. The ammeter is very sensitive to lack of balance, and can be used as an extensometer to reveal any elongation of the test piece during the course of the test.

The "compensating" spring S supports the weight of the armature and other vibrating parts, and is adjusted in stiffness so that it supplies exactly the force required to accelerate the massive parts in their small but rapid vibration. The spring is readily adjusted to suit different frequencies of operation, and it is customary to work at 2000 cycles per minute—each cycle including one pull and one push.

The compensating spring is used also for another purpose, as a means of carrying out tests with loads that vary between unequal values of pull and push, or pulsate wholly

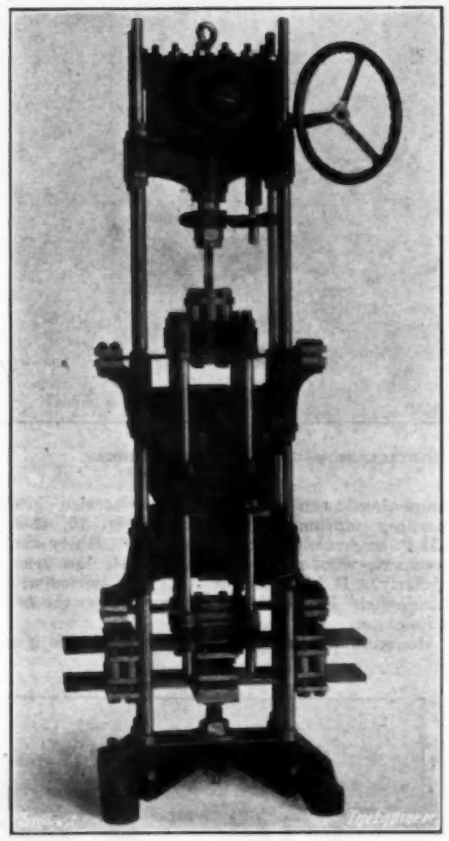


FIG. 6—6-TON HAIGH MACHINE

as pull or as push. To produce such load cycles, the spring is adjusted to give an initial pull or push supplementing the alternating force exerted by the magnets. The steady component force added by the action of the spring is measured by its deflexion, which is indicated on a scale with micrometer adjustment on the regulating screw.

The adoption of this device makes it possible to test metals under conditions that approximate very closely to real conditions of service. In many cases, the mode of failure and the stresses required to cause failure are quite different when pulsating loads are used instead of alternating.

(To be continued.)

New Lightning Arresters.

FOR use in lightning arresters a new material, called Thyrite, which has the property of increasing or decreasing its resistance as the voltage is decreased or increased, has been developed by the General Electric Company of America. The relationship does not depend on the rate of voltage application; it may be made to repeat itself indefinitely without change, and the resistance and current relationships follow a definite law, which can be expressed in the form of a simple hyperbolic equation. The change in resistance is such that the current increases 12·6 times each time the applied voltage is doubled. Particulars of the method of manufacturing Thyrite are not available, but it is stated that it can be manufactured successfully from the standpoint of duplication with proper control of materials and processes, and it can be produced in any shape that can be successfully moulded. The effect of increased temperature is slightly to decrease the resistance for any given voltage. The material is well adapted for use in a protective device, and lightning arresters of three different forms are now being tested in service. The station type of arrester is made in 11·5-kV sections, composed of Thyrite discs, which are assembled in a manner similar to pedestal insulators, the units being self-contained, and do not call for a series gap. An arrester for an earthed neutral, 69-kV service is approximately 87in. high, and for currents up to 1000 ampères the potential across the arrester does not exceed 2·8 times the arrester rating in crest volts. The protective characteristics of the distribution type of arrester are similar to those of the station type, although its impulse current capacity is but one-quarter of that of the station type.

The advantages claimed for the new arresters are small size, low installation cost, small weight, and the predictability of the results to be expected for any given condition. A new type of arrester for the protection of transmission lines against flash-over is being developed, and is incorporated in the insulator string. It is designed not only to prevent the flash-over of the insulator string, but also to absorb a considerable portion of the energy of the discharge. Laboratory experience with the cathode ray oscillograph gives definite knowledge of the protective characteristics which can be calculated for any given circuit, whilst tests in the field on high voltage transmission lines with portable impulse generators have successfully demonstrated the ability of the arrester to prevent the continuous flow of power current following the impulse. The ability of an arrester successfully to withstand all the conditions of operation without failure cannot, however, be completely determined in the laboratory. It is necessary for the arrester to pass through a certain period of trial in actual service which will determine whether the factor of safety employed is correct. For several months arresters have been in service on lines up to 66 kV, and others are shortly to be put into operation on 110-kV and 132-kV lines. An arrestor rated at 69 kV is composed of seventy-two Thyrite discs, 3in. in diameter and 1in. thick.

A new lighting arrester has also been introduced by the American Westinghouse Company. Like this company's auto-valve arrester, this new type employs discs fired in an electric furnace, but the new discs are porous and thicker and fewer in number than those used in the older type. A single porous disc, 1in. thick and 2in. in diameter, will deal with a 1000-ampère discharge from a 2300-volt line. For this purpose the present auto-valve arrester employs sixteen discs, making a stack 2·25in. high. Like that of the original arrester, the protective action of the new arrester depends on a glow discharge, but whilst in the former case the discharge occurs on the surfaces of the separate discs, in the new type the discharge is confined to the pores, the size and number of which are the result of careful calculation and experiment. The diameter of each pore is said to be in the neighbourhood of 25/10,000th of a millimetre, but the number of pores is such that the total area of their inside walls is approximately 200 square feet for each disc. In effect, each of these many million pores deals with a part of the discharge. Not only is the new arrester smaller than the older type, but its characteristics are also said to be better. The ratio between the voltage at which an arrester begins to discharge and that at which the discharge ceases should be small, as it is a gauge of the excess voltage which the line must stand. In the new arrester the ratio is exceptionally low. Arresters of this type might be placed on transmission lines at frequent intervals. It is suggested, in fact, that they might be placed at every tower, but whether this will become common practice remains to be seen.

SIXTY YEARS AGO.

IN 1866, after much hesitation on the part of the Government, Captain Cowper Coles was entrusted by the Admiralty with the production of an efficient sea-going cruiser of the turret type. He was given almost unlimited powers in the design of the ship and was permitted to choose his own builders. He selected Messrs. Laird, and in due time H.M.S. "Captain" was completed and launched. In our issue of March 4th, 1870, we recorded the fact that the vessel had that week tried her machinery over the Stokes Bay measured mile, and that her continuous steaming trial was likely to be carried out during the following week. The vessel had a length of 335ft., an extreme breadth of 53ft. 3in., a designed draught of 23ft. 6in. aft and of 22ft. 6in. forward, and a freeboard of 8ft. Her two sets of engines had a total output of about 5400 horse-power and were of the double-trunk type. Steam was supplied by eight boilers. On her measured mile trials she carried 700 tons of coal and was ballasted up to her full service weight. It was noticed that her draught was greater than was expected and that the freeboard was only 6ft. 6¼in. instead of the designed 8ft. In moderately favourable weather she developed on six runs over the measured mile an average speed of 14¼ knots under full boiler power. Turning trials were also carried out. The steering qualities of the vessel were found, so we reported, to be perfect, and satisfactory proof was provided that in the "Captain" we had received an efficient addition to our ironclad fleet. The vessel, as we now know, was, however, gravely deficient in stability. Six months later, on the night of September 6th, 1870, she capsized at sea and all but eighteen of her crew of 500 were drowned. . . . In a letter to the Editor a correspondent in a humorous vein called attention to the fact that Mr. (Sir Henry) Bessemer, temporarily turning away from metallurgy, had patented a method of preventing sea-sickness. The invention consisted of mounting the passengers' quarters in a ship on gimbals, the idea being that when the ship rolled the cabin would remain steady. Our correspondent had searched the Patent Office files and had found that Bessemer had been anticipated in 1853 by Mr. F. Schneider, who proposed a system of an almost identical nature. He was also anticipated, so our correspondent argued, in the same year by Mr. H. de Namara, who proposed to attach balloons to seats supported beneath on ball and socket joints. Bessemer's vessel with her swinging cabin was actually constructed and was placed in service on the cross-Channel route. It was his intention at one time to control the motion of the cabin by a gyroscope operating a system of hydraulic rams. A misunderstanding of the principles of the gyroscope led him, however, to abandon its use and to resort to a hand control of the rams. The invention was not successful and the swinging cabin was removed from the vessel. The cabin, it may be added, is still in existence and is in use to-day on land as a lecture room of a ladies' college near London.

The British Industries Fair.

No. II.*

WE continue below our account of the exhibits at the Birmingham section of the British Industries Fair, which closes this evening, after what we believe to have been a very successful fortnight. In our opening remarks of last week we commented on the sparseness of the attendance during the first day or so, but must now tell of a steadily increasing flow of visitors, who, during the earlier part of the afternoon, were, obviously, technically interested in the exhibits. During the later hours of the day, however, there was generally an incursion of what appeared to be sightseers, which resulted in a certain amount of congestion, particularly around stands upon which demonstrations were given. With the object of making the most of the space available the gangways are not over-wide, and if the organisers decide that the attendance of the general public is desirable it may be found necessary in future years to leave more room for circulation. It should be easy to provide for the admission only of business people during the first few days of the Fair, and the useful propaganda, which results from public attendance, might be encouraged during the concluding days.

THE PREMIER ELECTRIC WELDING COMPANY, LTD.

Examples of drooping characteristic single-operator welding machines, driven by direct-current and alternating-current motors, and in one instance by a four-cylinder Dorman engine are shown by the Premier

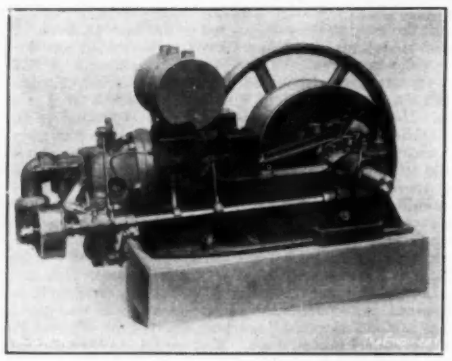


FIG. 11—10 B.H.P. OIL ENGINE—RUSTON

Electric Welding Company, Ltd., of Abbey Wood, London, S.E. 2. The whole of the switchgear associated with the "Premier" single-operator units is enclosed in a weatherproof steel box, and there is no exposed wiring. A range of welding transformers with choke coil regulators is also shown. The two principal examples on view are a 200-ampère transformer of the air-cooled type, and a small 75-ampère transformer designed for welding thin sheet metal. As the latter transformer has an open circuit pressure of only 40 volts on the secondary side, its energy consumption is very small, and it can be connected to any ordinary single-phase lighting circuit. The cost, we are told, is low, and it is considered that it should appeal strongly to manufacturers of sheet metal equipment and garage proprietors. Multiple-operator type machines are represented by a two-operator motor generator plant, constructed on the "Premier" principles. The plant delivers direct-current welding current at 35 volts to a number of welding operators, and is claimed to be the most efficient plant on the market. Samples of work exhibited show the special applications of the "Beefinish" electrode, and among these samples are the original test pieces which were made to the requirements of Lloyd's Register, and which resulted in the approval of the Premier system of welding in connection with ship constructional work. Visitors also have an opportunity of studying the company's "Premag" process of welding, which has been worked out in conjunction with Imperial Chemical Industries metals. It is an oxy-acetylene process for welding copper, and is claimed to give exceptionally good results.

* No. I. appeared February 21st.

RUSTON AND HORNSBY, LTD.

A working exhibit of historical interest is to be viewed on the stand of Ruston and Hornsby, Ltd., of Lincoln and Grantham. It comprises engine No. 101, which, together with No. 102, formed the first installation of Hornsby oil engines, which were installed for pumping work at the Fenny Stratford Waterworks, Great Brick Hill, in 1892. After

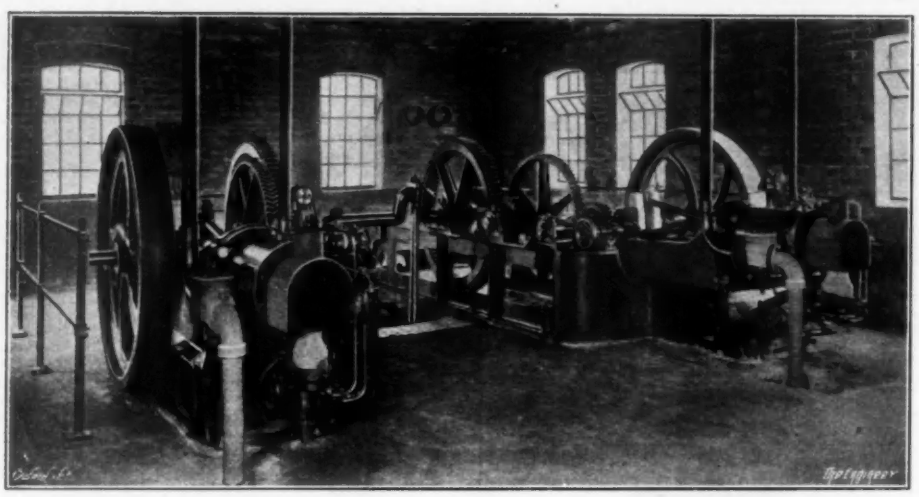


FIG. 10—THE FIRST HORNSBY OIL ENGINE INSTALLATION—RUSTON AND HORNSBY

completing twenty-nine years of service in the pumping station illustrated in Fig. 10, this 9½ B.H.P. engine was purchased by a Bletchley timber merchant, who, since January, 1921, has used it regularly. It has been lent for the period of the Birmingham Fair and will be returned to the owner at its close.

Alongside the old engine there is shown a new Ruston 10 B.H.P. petrol-paraffin unit—see Fig. 11—with a cylinder bore of 6½in. and a stroke of 10½in., developing its full output at 400 r.p.m. There is also a 22 B.H.P. engine of the cold-starting airless injection type. This unit has a bore of 8½in. with a stroke of 15in. and runs at 330 r.p.m. The vertical type of airless injection engine is represented by a three-cylinder 67 B.H.P., 500 r.p.m. engine, with cylinders 7¾in. diameter and with a stroke of 11in. For this engine the patented "Streamline" filter forms an integral part of the lubricating oil system and is constantly in operation when the engine is running.

For the starting of large oil and gas engines the firm has designed a new type of combined oil engine and air compressor, which is shown in Fig. 13. It consists of a 2½ B.H.P. petrol or paraffin engine, coupled direct to a single-stage vertical water-cooled air compressor, both units being enclosed in one compact casing. The compressor has a designed capacity of 10·6 cubic feet of free air per minute when running at 560 r.p.m., and its maximum delivery pressure is 300 lb. per square inch. The set, complete with the exhaust silencers and the fuel oil tank, only weighs 3¾ cwt.

Another exhibit of especial interest to road engineers

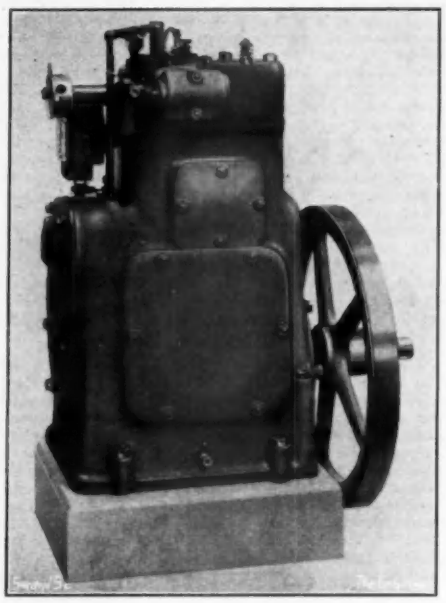


FIG. 13—STARTING AIR COMPRESSOR—RUSTON

is the Ruston oil engine-driven road roller, illustrated in Fig. 12. It has a cast steel frame with steel rollers, the rear roller being furnished with water ballast. Two speeds in either direction are required, one of ¾ mile per hour and the other 2½ miles per hour. The engine used is of the medium pressure type, with a designed output of 20 B.H.P. at 360 r.p.m., the cylinder bore being 9in. with a stroke of 13½in. Helical gears are used between the engine crank shaft and the clutch shaft and spur gearing for the final drive to the rollers. A quick reverse gear is provided with two separate friction clutches, so that no gears require to be disengaged while carrying out the reversing operation. Suitable arrangements are made

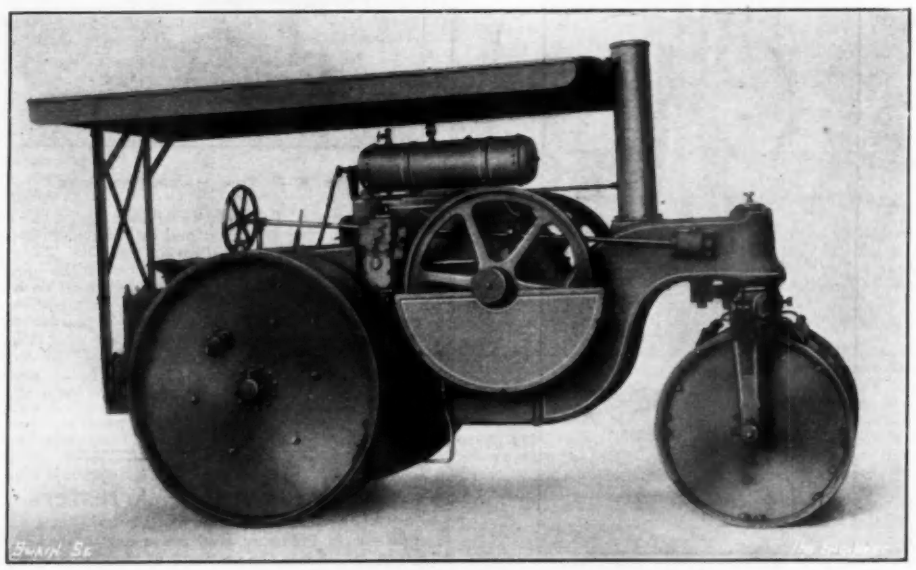


FIG. 12—OIL ENGINE-DRIVEN ROAD ROLLER—RUSTON AND HORNSBY

for disconnecting the travelling gears, so that the engine can be conveniently employed for belt-driving work.

RUSTON-BUCYRUS, LTD.

This year the excavator of the recently amalgamated Ruston-Bucyrus Company, of Lincoln, is not actually digging in the Fair buildings, but is shown in operation in sham digging. The model now exhibited is of the overcast type, and consequently would not be adaptable for confined exhibition in actual work. It is illustrated by the half-tone engraving Fig. 14, while several of its details are shown in the drawings Figs. 15, 16, 17. It is noteworthy that the machine

displayed its mobility by travelling from the truck, which brought it to Castle Bromwich by rail, unaided, to the maker's stand within the Fair buildings.

The machine is nominally of ½ cubic yard capacity and is capable of being readily converted into a drag shovel, a skimmer or a grabbing crane. It is, it will be seen, carried on caterpillar tracks, the details of which are illustrated in Fig. 16. Each of the two self-laying tracks is built up from a number of cast steel shoes; each shoe is sufficiently strong to carry the maximum possible load. The links are connected by nickel steel pins, fitted with locking pins to prevent turning, but allowing for easy connection or disconnection of the shoes. The shoes or track links are of box section and are so designed that mud and dirt cannot easily be carried round on the links to fall between joints on to the rotating parts. On account of the construction of the track links it is, we believe, practically impossible for dirt or stones to be picked up and wedged between the links. Each track is supported by one driving sprocket, one idler wheel, and two rollers, each a heavy steel casting. The driving axle is at one end of the track, and at the other end an adjustable axle provides for taking up any slackness in the caterpillar tracks. It should be mentioned that fitted to the brackets carrying the adjustable axle are springs which act as a cushion to relieve stresses that would arise if the tracks and sprockets became packed with dirt.

Two driving speeds are provided on the machine, 0·5 miles per hour and 1 mile per hour, and the drive is by gears throughout, which are fully enclosed and protected. The machine can be steered from the driver's seat and will turn in its own length, each track being separately driven in a forward or reverse direction, or positively locked singly or together. To turn gradually in one direction the inside track may be declutched and allowed to drag free, while the outside track is driven; to turn sharply, the inside track is locked positively while the track on the outside of the curve is driven. The nickel steel adjusting screws in the brackets carrying the adjustable axle are of such design that if the tension exceeds a safe figure, as a result of abnormal strain due to the tracks becoming packed, the screw will break instead of more important parts.

An oil engine drives the machine at the Fair, but alternative designs with petrol engines, as shown in Fig. 15, or electric drive are provided for. The oil consumption is said to be ¼ to ¾ gallon per hour. The power from the engine is transmitted through a single dry plate clutch running in ball bearings. The power for the hoisting and digging motors is transmitted from the engine through the clutch and thence by spur gears which are totally enclosed in a dust-proof casing. The hoisting and digging motions are controlled by two drums of large diameter and tapering section to facilitate the correct winding of the coils on the drums, and extend the life of the ropes. Both drums are mounted on the same shaft side by side, which gives a compact space-saving arrangement, and has the additional advantage that the rope leads from the jib pulleys or the fairlead only move through a small arc. The operation of the main clutch—see Fig. 17—is effected by a simple form of dry plate "servo" clutch, which is put into operation by means of a quick-thread screw, and as the revolving portion engages with the stationary drum it actuates a train of levers which engage the main band clutch. The hoisting and digging brakes are operated by a foot pedal placed in a convenient position for the driver.

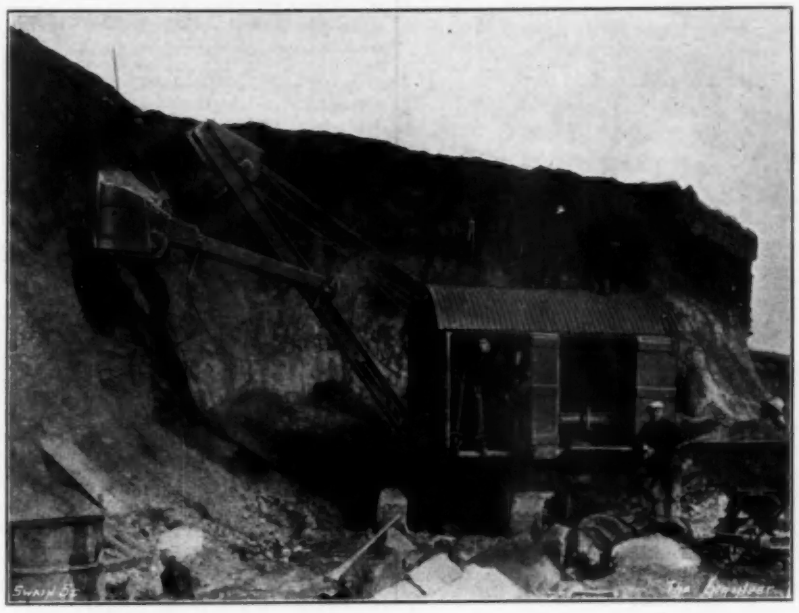


FIG. 14—OIL ENGINE-DRIVEN EXCAVATOR—RUSTON-BUCYRUS

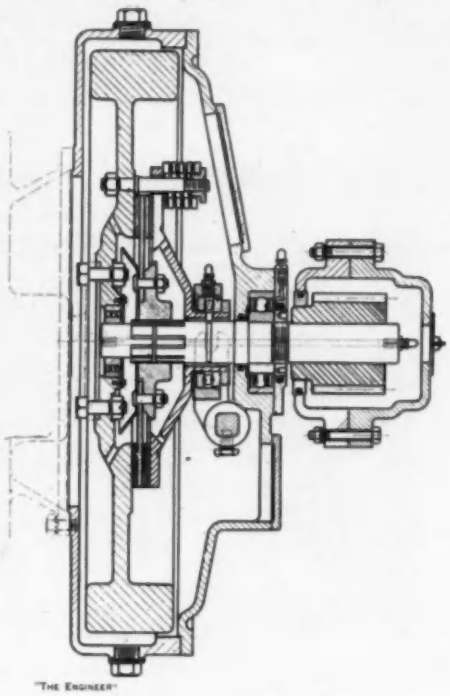


FIG. 17—CLUTCH AND GEAR DRIVE

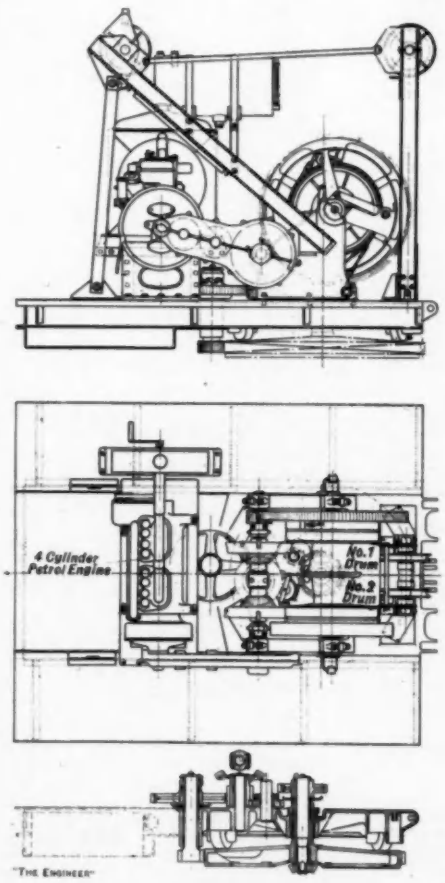


FIG. 15—DRIVING MECHANISM

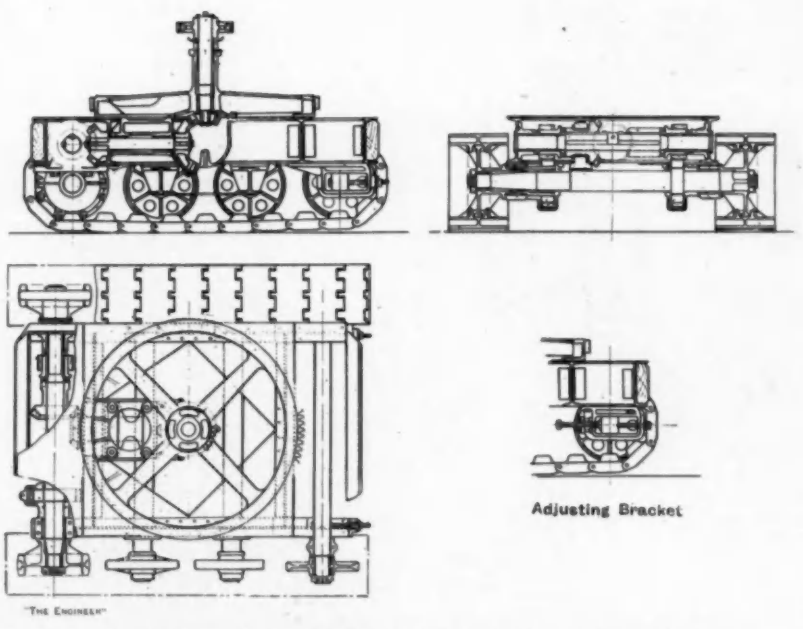


FIG. 16—DETAILS OF CATERPILLAR TRACKS—RUSTON-BUCYRUS

THOS. FIRTH AND SONS, LTD., SHEFFIELD.

One of this firm's stands is devoted to demonstrations of engineers' tools, including the latest metal saw, and "the Firth Insto" at work, together with hacksawing machine and saw sharpeners. In addition to these demonstration exhibits, there is a comprehensive range of engineers' tools, including twist drills, milling cutters and reamers of standard and special types. A special feature is being made of the "Die-hard" high-speed cutting files. On another stand there is a comprehensive display of Firth "Staybrite," consisting of a thousand and one articles which are produced from this steel, in fields as wide apart as domestic appliances and paper-making machinery. The finished polished sheet supplied by the Blackheath Works of the company is shown, and demonstrates the enormous strides which have been made in the technique of polishing during the past twelve months.

BROOKES (OLDBURY), LTD.

The guillotine shearing machine shown in Fig. 18, which is exhibited on the stand of Brookes (Oldbury), Ltd., of Oldbury, near Birmingham, is novel in several respects. It is intended for cutting steel plates up to

½in. thick by 6ft. long, and is equipped with a holding-down beam, plainly shown in the engraving, fitted with rubber buffers for keeping the plate in intimate contact with the table. The hold-down is cam operated, as is also the cutting knife, from one shaft running along the base of the machine, the two operations being performed automatically in succession. The cutting knife is provided with an adjustment so that it can be brought into intimate contact with its mate, and also has a series of vertical adjusting screws, which can be used to keep its cutting edge in proper alignment.

We had some doubt, on viewing the machine at the

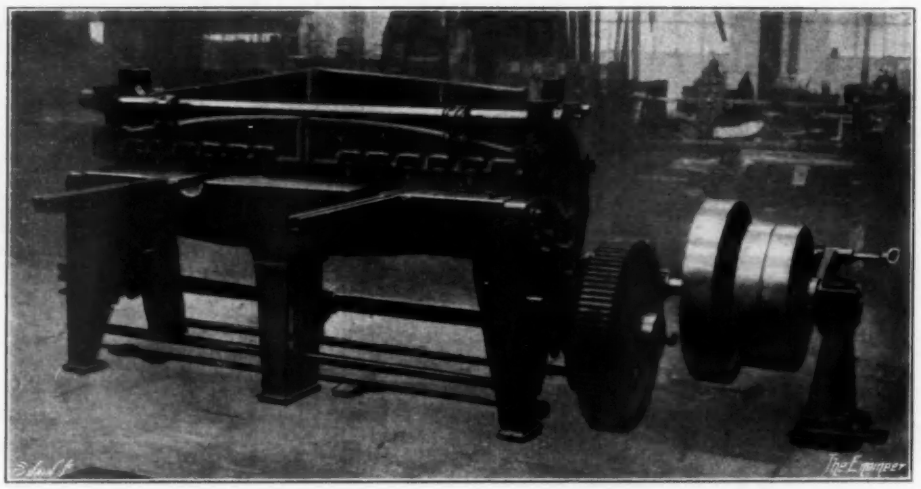


FIG. 18—GUILLOTINE SHEARING MACHINE—BROOKES

Fair, as to the efficacy of rubber for holding down purposes, and consequently asked the makers to shear the thinnest plate they could find. A piece of sheet steel of about No. 20 gauge was produced and a cut made some 4ft. long. It was quite straight and the edge was not curled over in the least, while the arris was hardly distinguishable. These shears are made in various sizes for cutting plates up to ⅜in. thick, while there is an overhead type for cutting plates up to ½in. thick.

There is also on this stand the planishing hammer illustrated in Fig. 19, which, it will be seen, has a movable fulcrum, so that the length of the stroke can be varied. It has a pneumatic head to absorb the

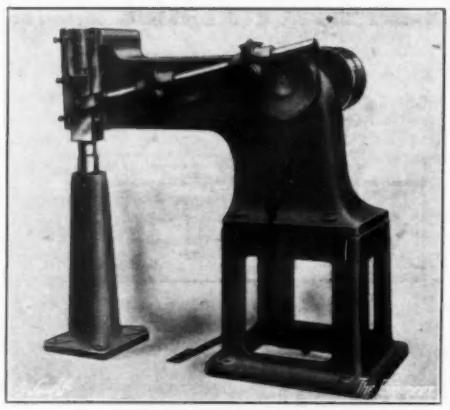


FIG. 19—PLANISHING HAMMER—BROOKES

shock of the blows. Another machine is an open-fronted geared power press on upright stands. This press is driven through a patented roller key clutch provided with a mechanism that prevents the press from making more than one complete revolution whether the pedal is released or not. Provision is, however, made for making the clutch inoperative, should it be desired to run the press continuously, but this alteration can only be effected by the charge hand of the shop. This press is fitted with the firm's patented all-steel duplex connecting-rod, which is gun-metal bushed and machine-cut gearing.

NOBEL CHEMICAL FINISHES, LTD., AND THE FREDK. CRANE CHEMICAL COMPANY.

Manufacturers of industrial articles are fully aware of the value of an attractive and durable finish on their products. New and improved finishes are continually being evolved at the request of manufacturers for a material which would give their products greater beauty or distinction than that of their competitors. Some interesting developments in the finishing field are to be seen on the stands of Nobel Chemical Finishes, Ltd., and the Fredk. Crane Chemical Company, both associated companies of Imperial Chemical Industries, Ltd. Finishes of all kinds, including cellulose lacquers and enamels, clear and coloured for application by brush, spray, or dip, and, in addition, a large number of oil paints, stoving enamels and fancy finishes are to be seen on the stands of these two companies, the majority of the new finishes being for articles that find their places in the home. A particularly artistic finish shown on the stand of Nobel Chemical Finishes, Ltd., is that for pen sticks and other small articles. This finish is obtained by what is known as the "marking process," which provides a colourful cellulose finish that is very durable. Another type of finish particularly suitable for giving a distinctive appearance to art metal ware is that obtained with "Necol" cracking enamel. This process consists of applying first a ground coat of one colour and then applying over this ground coat a coat of contrasting colour. This second coat shrinks as it dries, and draws away like ink on greasy paper, and reveals below the ground colour first applied. Particularly interesting exhibits on the Fredk. Crane stand are the wide variety of clear lacquers suitable for application by spraying, brushing, or dipping, and the coloured "Cranco" cellulose enamels, which are shown applied to pottery, glass, and metal articles.

Other attractive finishes shown on this stand are obtained with Crane's cracking, crystalline and crinkle enamels. These finishes are fully illustrated, and in a number of cases special panels on which each stage of the application process is clearly shown have been prepared.

DAVIDSON AND CO., LTD.

There is a diversity of plant on the stand of Davidson and Co., Ltd., Sirocco Works, Belfast, two items of which we illustrate in Figs. 20 and 21. There are, besides these, a number of Sirocco fans and a flue

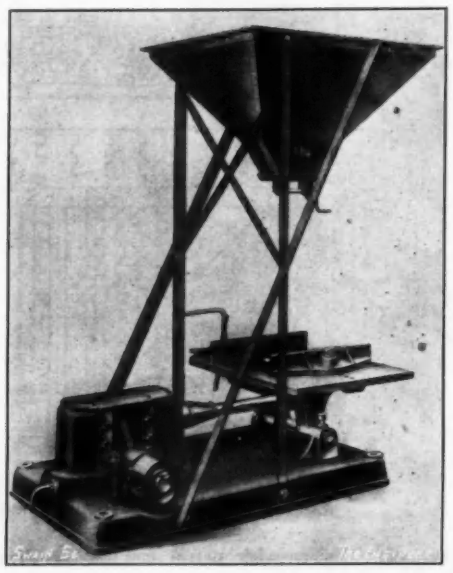


FIG. 20—PACKING MACHINE—DAVIDSON

dust collector, but these are quite familiar to our readers, so we will not enlarge upon them here.

The packing machine shown in Fig. 20 is intended for packing into receptacles the maximum possible quantity of material in granular or powdered form without the application of pressure. It consists of a rocking table fitted with screw-operated clamps for gripping the case to be filled, mounted on a cast iron bed-plate, a portion of which forms the chamber for enclosing the rotating parts and bearings. The rocking table is vibrated by means of a connecting-rod, which is coupled to a bronze rocking link mounted on an excentric turned on the shaft. The shaft runs in gun-metal lined bearings which, together with the excentric, are totally enclosed in a chamber. The chamber is provided with an oil reservoir and the moving parts are all self-lubricating when in motion. This lubrication system is not only very effective, but special precautions have been taken to prevent oil leakage, thereby ensuring cleanliness and eliminating waste of lubricant. A feature of the packer is the thorough enclosure of the rotating parts and bearings, which prevents the dust produced in the course of packing from lodging in them and consequently prolongs the life of the machine. The packer is practically noiseless in operation.

The air conditioning plant shown in Fig. 21 is of that type in which the air is cleansed of any impurities by being subjected to a washing process by means of a number of sprays of water, and is then passed

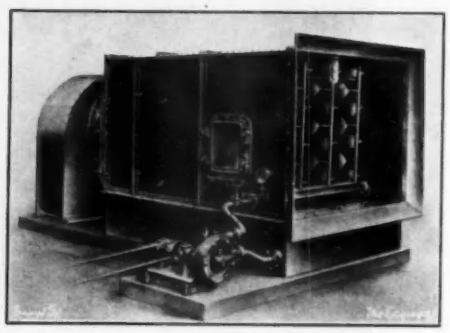


FIG. 21—AIR CLEANER—DAVIDSON

through a baffling system to extract any entrained water. Its general construction can be followed in the illustration. There is on this stand a model of a mine ventilating fan, which has transparent side plates to show the style of the impeller and the arrangements for reversing the air current.

THE CASSEL CYANIDE COMPANY, LTD.

In conjunction with Imperial Chemical Industries, Ltd., the Cassel Cyanide Company, Ltd., of Glasgow and Oldbury, is demonstrating the hardening of metal parts by the cyanide process. A feature of this process is the remarkable rapidity with which the process can be carried out. Very little time is required to carburise the surfaces of metal parts to a depth of, say, ten-thousandths of an inch, while in 2 to 2½ hours surface hardening to a depth of $^1/_{32}$in. is easily effected.

Particular surface finishes which are obtained by the use of cyanide and other melts are displayed by means of samples.

In connection with the process demonstrated, it is of interest to learn that the Cassel Cyanide Company, Ltd., has recently equipped at Oldbury a new plant which is specially designed for the case-hardening of metal parts on the basis of a 24-hours' service. So far as we are aware, this type of service would be difficult to achieve with other forms of surface hardening. The exhibit shown is one which will certainly be of interest to engineers, as actual tests can be made on the stand in a very short time.

BLACKSTONE AND CO., LTD.

When describing in our last issue the exhibits of Blackstone and Co., Ltd., of Stamford, we called attention to the fact that since the works were founded in 1896, over 25,000 Blackstone oil engines had been supplied. The date 1896 refers, of course, only to the building of the first oil engine and the beginning of the oil engine works. The original business of Blackstone and Co., Ltd., was established in 1837, and previous to taking up the manufacture of the oil engine the firm specialised in steam engines, agricultural machinery and grinding mills, which two latter classes of work still form an important part of the firm's business.

(To be continued.)

ADDRESSING the Royal Society of Arts on "Recent Improvements in Brickmaking," Mr. Alfred Searle said that so many changes had occurred during the past 20 years that it was somewhat surprising to those unacquainted with the technicalities of the subject that bricks still remained the most popular, as well as the most pleasing, of artificial building materials. During, and shortly after, the Great War, many ingenious attempts were made to use substitutes of various kinds for bricks, and for a short time great interest was taken in those novelties. With two exceptions they were now seldom noticed, and out of the medley of suggestions and "inventions" of 1916–1925, only bricks, hollow blocks—sometimes known as cavity bricks—and concrete in various forms remained. The erroneous idea, prevalent for several years, that houses could be built of concrete more cheaply than of bricks had now almost disappeared, and with an increasing demand for beauty in the colour as well as in the form of modern houses, the use of bricks had correspondingly increased. Even in large quantities, houses could be built more cheaply of bricks than with concrete, and brick houses were far more comfortable.

Railway and Road Matters.

THE Southern Railway Company's locomotive No. W 13, "Ryde," was built in 1864 for the Isle of Wight Railway by Beyer, Peacock and Co. It is still in service in the island and has run 1,502,638 miles during its life of sixty-six years. It is a 2–4–0 tank engine.

THE receipts of the Great Western Railway purely from railway working last year were £31,028,475, as compared with £30,485,620 in 1928, and the expenditure £24,308,541 as against £24,476,445. The receipts from other businesses brought the gross receipts to £36,184,053, and the expenditure thereon made the gross expenditure £29,208,791, as compared with £35,527,544 and £29,408,172 respectively in 1928. The net receipts were thus £6,975,262 as against £6,119,372.

THE G.W.R. announces that as a result of increasing demand 100 special trucks are to be built at its Swindon works for the conveyance of new cars from manufacturers' works, at Birmingham and Oxford, to all parts of the country and docks for export. A further fifty covered containers and twenty-five insulated containers, for the conveyance of meat and other perishable traffic, are to be ordered. Last year the company recorded an increase of 211 per cent. in tonnage carried in containers over 1928. It now has 518 in daily use.

THE dividend announcement made by the London and North-Eastern Company on February 21st is a good finish to the records of railway dividends for last year made in this column on the date just named. When it is remembered that a year ago the company distributed only ¾ per cent. on the preferred ordinary stock, and now pays 3 per cent., it will be appreciated how well the L. and N.E.R., in particular, has done. Moreover, a sum of £500,000 has been transferred to general reserve, and £81,000 carried forward, as against £27,000 carried forward in 1928.

THE Southern Railway Company's report for 1929 shows that the receipts from railway working were £22,992,509, as compared with £23,010,391, and the expenditure thereon £18,174,507, as against £18,447,102. The receipts from, and expenditure on, other businesses brought those figures for 1929 up to £26,507,018 and £20,914,249 respectively, as compared with £26,516,805 and £21,143,111. The net receipts were therefore £5,592,768 as against £5,373,784. The company carried nearly 209 million passengers as compared with 202 million in 1928, and of this increase 3 million was from third-class passengers and nearly 4 million from workmen. The tonnage rose from 16,894,952 to 17,759,514; most of the increase was in coal.

THE official statement following the announcement that the London, Midland and Scottish Company has placed an order with the Sentinel Waggon Works, Ltd., for four 100 H.P. double-geared shunting locomotives prompts a reference to a paragraph which appeared in this column of our issue of March 29th last. In a paper read on January 8th, 1929, at the Newcastle and Sunderland Railway Lecture and Debating Society it was stated that as a result of the use of these engines by the London and North-Eastern Railway to shunt wagons into station order at country stations in anticipation of the arrival of the pick-up freight train, it had been possible to rearrange the steam engine workings so that only two were required instead of three.

THE recent announcement that the London, Midland and Scottish Railway is to spend £750,000 on its Southend line prompts the remark that certain improvements there are long overdue. As related in this column on June 29th, 1928, a parliamentary condition of the line being acquired by the Midland Railway, under powers given in 1912, was that before 1914 sanction was to be obtained for the conversion of the whole line for electric traction. In 1914 the limit was extended to 1916, but all that has been done is to equip the two lines—out of four—between Campbell-road Junction, Bow, and Barking. The two lines between Barking and Upminster were to be widened to four. Nothing has been done either under that heading. What is now proposed is to widen the line from Barking to Dagenham—about half-way to Upminster—and to equip the additional lines for electric traction. The station at Leigh-on-Sea is to be reconstructed, a new one is to be built at Chalkwell, and Gale-street Halt is to be converted into a regular passenger station.

ON October 1st last a London and North-Eastern up morning passenger train from Aberfoyle to Glasgow was running between Gartmore and Buchlyvie, when the engine and the whole of the train of two horse-boxes and eight bogie coaches was derailed at a point 2 miles from the latter station. The engine was No. "2690," of the "N 2" class and the "0–6–2" type tank, with radial axle. It weighed, in full working order, 70 tons 8 cwt., and was built by the Yorkshire Engine Company, being put into service in March, 1929. It was working on the Aberfoyle branch between April 3rd and June 11th, and again from September 24th to the date of the derailment. Four similar engines, built between March and December, 1925, have also been working with considerable regularity on the branch since October, 1928. There are two speed limits of 30 m.p.h. in the vicinity of the place of derailment; one ended 846 yards on the Aberfoyle side of the place of derailment and the second commenced 400 yards on the Glasgow side. The speed at the time of the accident was between 30 and 40 m.p.h. Colonel Anderson inquired into the derailment, and his report, issued on February 20th, says that in his opinion it was due to the running of heavy tank engines on a line where the track was of only light construction and the standard of maintenance low. The existence of excessive and incorrect superelevation, particularly on the straight immediately before the point of derailment, and the variations in the gauge indicated the punishment which the road was receiving from these engines. Colonel Anderson's concluding remarks are that the accident again illustrated the need for full consideration of their effect before a decision was taken to run heavy tank engines, even at moderate speeds, on a section of line where the track was of only light construction. As an irregularity in the weight of the engine was discovered, the inspecting officer further said that the importance of keeping the springs of such engines in correct adjustment was a matter to which he thought more attention might well be given.

Notes and Memoranda.

ACCORDING to reports received by the United States Department of Commerce, establishing several new records, production of motor vehicles in the United States in 1929 totalled 5,358,361 units, against 4,350,759 in 1928. Passenger car output last year was 4,586,020, against 3,821,136 the previous year; while production of trucks totalled 754,752 and 530,910 respectively in the two years.

COMPLAINTS from Swedish wireless listeners have led the Swedish Government Radio Department to establish a new kind of "Scotland Yard." The new establishment is a special control station in the little town of Eskilstuna in central Sweden. The cause of the complaints of the listeners, who have been disturbed by insistent and powerful interferences, has now been traced by the radio police. It was found that a wireless transmitting station in a certain capital of a central European country had not respected the International Radio Convention, which it had signed, but arbitrarily changed its wavelength, with the result that it conflicted with that of Sweden. The country in question has been officially requested to change its wave-length to conform with the Convention, but, so far, it is said, without result.

FROM *Nature* we quote the following paragraph *in toto*: "The relationship between the engineer concerned with petroleum and the industry itself is not easy to define. It is usually clouded by argument as to whether the engineer made the oil industry or the industry the oil engineer. It is further complicated by lack of agreement as to what really constitutes the engineer in the oil industry, since, according to circumstances and national custom, the designation may imply anything from a raw driller's assistant to the highly trained and technically qualified consultant. This would seem *prima facie* a case for a formula, but Mr. John Gillespie's discursive paper on the subject at the Institution of Petroleum Technologists on December 10th cannot be said to have supplied one. If one takes the stand at the outset that 'the engineer *is* in the forefront, and forms, and will always form, the spearpoint in this line of attack upon the . . . resources which Nature has hidden . . .,' then obviously the engineer made the oil industry and the relationship becomes practically parental."

AN increase of 9·2 per cent. in electricity produced for public use in the United States during 1929 over the 1928 production is estimated by the National Electric Light Association, and the total, 97,000,000,000 units, is reported to be 17·5 per cent. in excess of the 1927 production. During the year 850,000 new customers were added, bringing the total of consumers now served up to 24,050,000, of whom nearly 20,000,000 are domestic users. While factory consumption is said to have increased by 10 per cent., an increase of 16 per cent. in domestic consumption is reported. The Association states that approximately 68 per cent. of the population of the United States is now living in electrically-wired homes, and that in the past seven years 9,600,000 homes have received electric service for the first time. The population living in electrically-wired homes is stated to have increased 520 per cent. in the period between 1912 and 1927, although the population increased by only 24 per cent. in that time. A quarter of a million farms are stated to have been connected for electric service during the past three years, making a total of more than 500,000 farms now electrified.

IN an address to the Optical Society on February 13th, the President explained that "optics," which originally meant the science which treats of light and the phenomena of vision, had, by general consent, come to include the phenomena of infra-red and ultra-violet radiation. The time was now ripe for a further extension to include ether radiations, such as those used in radio transmission and the X-rays. Not only, the President continued, did the propagation of all those radiations follow the same laws, but the manifestations of them, which had become of interest in recent years, were often of a nature long familiar to those dealing with optics. Furthermore, some of the recent developments had resulted from the application of minds trained in optics to consideration of those other radiations. Illustrations included the polarisation and interference of radio waves, the latter phenomenon enabling the height of the Heaviside layer to be determined; while the use of the notions associated with the diffraction grating had resulted in novel suggestions for beam radio transmission. The "optical" phenomena of X-rays included the formation of characteristic spectra of the elements by the use of a crystal in a manner closely analogous to that in which the well-known optical spectra were produced by means of a diffraction grating.

THE United States Bureau of Standards has been co-operating for several years with rail manufacturers and railways in a study to determine the origin of rail failures, particularly the type known as transverse fissures. In previous work the Bureau made an extensive study of the endurance properties of both new and used rails. These studies led to the conclusion that the nucleus of the transverse fissure was probably present in the new rail before placing it in the permanent way, and that the fissure developed in service from that nucleus. The origin of the nucleus is obscure. It was thought to be a crack or group of cracks of microscopic dimensions which formed in the rail while hot at some time during its manufacture. A study has therefore been made of the strength and ductility of rail steels at elevated temperatures. It has been found that in the temperature range 500 deg. to 700 deg. Cent. the ductility of some rail steels and certain other steels is relatively very low. This range of temperature has been termed the secondary brittle range, and the phenomenon secondary brittleness, these terms being given to distinguish the phenomenon from the well-known phenomena of blue brittleness and hot-shortness in steel. A study was also made to determine the temperative distribution in a rail during cooling under different conditions. These investigations have shown that under certain conditions of cooling, owing to the large temperature gradients present, the stresses developed in a rail or other steel structure while cooling through the secondary brittle range may be sufficient to cause internal ruptures which may act as nuclei for fatigue failure—transverse fissures—in service.

Miscellanea.

SOME half-dozen large steam power stations will be laid down during the next year or two in the Northern Rhodesian copper fields. Hydro-electric development may follow later, but the industry cannot wait for it.

TWO extremely interesting vehicles have just been presented to the Musée de la Voiture et du Tourisme by Madame Amédée Bollée, widow of the well-known engineer. One is the steam car called "La Mancelle," built in 1873 by Amédée Bollée, sen., the other the first petrol-driven car built in 1895 by Amédée Bollée, jun. The museum is being formed at the Palace of Compiègne.

IN a recent lecture on "Some Desirable Changes in Patent Law," before the Institute of Patentees, Major H. Fletcher Moulton said that we should approximate our law to that of the United States by permitting a patentee to obtain a patent even if he had disclosed the invention, provided that he applied within six months. The Patent Office search of this country should be extended to include foreign specifications and standard text-books, but if the patent showed something which was new, in view of those searches, the patentee should be allowed to obtain a patent as at present at his own risk as to subject matter. It might be advisable in some cases to permit of the system of re-grant, where, by error, the true invention had not been claimed.

THE Canadian Department of National Defence, Ottawa, has ordered five "Vancouver" flying boats from Canadian Vickers, Montreal, at a total figure of about 350,000 dollars, to be used as replacements for obsolete flying equipment employed in forest fire suppression. The "Vancouver" flying boat was developed by Vickers to meet the need of the Department for a large-cabin aircraft, which would be capable of carrying heavy loads at high speed, and of getting in and out of small lakes. It has an all-metal hull, and a wing span of 70ft. Its top speed is well over 100 miles an hour, while the cruising speed is 100 miles an hour. At that speed it will carry two pilots, a mechanic, and the equivalent weight of seven additional men. It is equipped with two engines of 325 horse-power each.

THE Central Examiners' report upon the examination for certificates of qualification as surveyors of mines, held in November, 1929, states that the Board's examiners who conducted the oral and practical tests report that weakness in the setting and manipulation of the theodolite, both on the surface and underground, was noticeable. Poor methods of chaining and of booking field notes were also observed. Fewer candidates than usual presented themselves for examination. The percentage that qualified was about equal to the average of the last two years, and much higher than in the earlier examinations. This reflects an actual improvement in work of the candidates, not any lowering of standard. The improvement is more marked in the work done in the practical examination than in the written answers to questions, but it is observable in both sections of the examination.

IN the House of Commons on Wednesday the Postmaster-General announced that the Government had decided to conduct wireless telephone services through its own stations at Rugby and Baldock instead of using the beam stations of the Imperial and International Communications Company. The beam service was leased to the Communications Company as a result of a recommendation made in 1928 by the Imperial Wireless and Cable Conference. The Postmaster-General held that the agreement with the Communications Company left him freedom to use either the company's stations or the Government stations for the purpose of developing a wireless telephony system and that the decision to use the Government stations would result in a considerable economy of expenditure. The Government's decision on this point has aroused adverse comment, and an opportunity for a debate upon it in Parliament has been sought and obtained.

THE Commercial Secretary to his Majesty's Legation, Athens, reports that he has been informed by the Greek Minister of Hygiene that, following upon the first Panhellenic Health Conference, which is to be held in Athens in April next, the Greek Medical Association proposes to arrange an exhibition of objects in connection with hygiene in general. The exhibition will be held in the Zappeion Building between May 1st and July 31st, and it has been announced that all exhibits will be free of Customs duty. They should reach Athens before March 31st. An Organising Committee is now making final arrangements with the President of the Republic and will shortly issue its programme. The hope was expressed to the Commercial Secretary that a number of foreign firms would participate in the exhibition. The exhibition is to be part of an active movement in Greece to increase and equip health centres in various parts of the country, to improve the sanitation of cities and to develop the new School of Hygiene at Athens on the lines recommended by the League of Nations Commission. British firms interested should communicate with Dr. Vlatianos, President of the Organising Committee, Panhellenic Health Conference, Odos Kriezotou No. 1, Athens.

IN a paper entitled "Some Considerations in the Design of Modern Refrigerating Plant," which was read recently by Mr. Bernard C. Oldham before the British Association of Refrigeration, the author states that for every ratio of suction and discharge pressures measured inside, and not outside a compressor cylinder with the same percentage of clearance, there is a constant factor, varying only with the exponential of the law of the compression and re-expansion curves, depending on the refrigerant or other vapour to be compressed, which, when multiplied by the suction pressure, gives the power consumed for a given piston displacement, either in a practical or in an ideal compressor. The author has devised a method by which these factors can be plotted on a chart to cover any range of ratios, and any value of the exponential "n" of the adiabatic law. An important feature of this type of chart is that it is universal for all refrigerants, or other vapours in any quality of vapour which is found in a correctly operated compressor, and is readily modified or expended to give factors for brake horse-power for any given mechanical efficiency, and also for either indicated or brake horse-power of supercharged compressors for any amount of supercharge.

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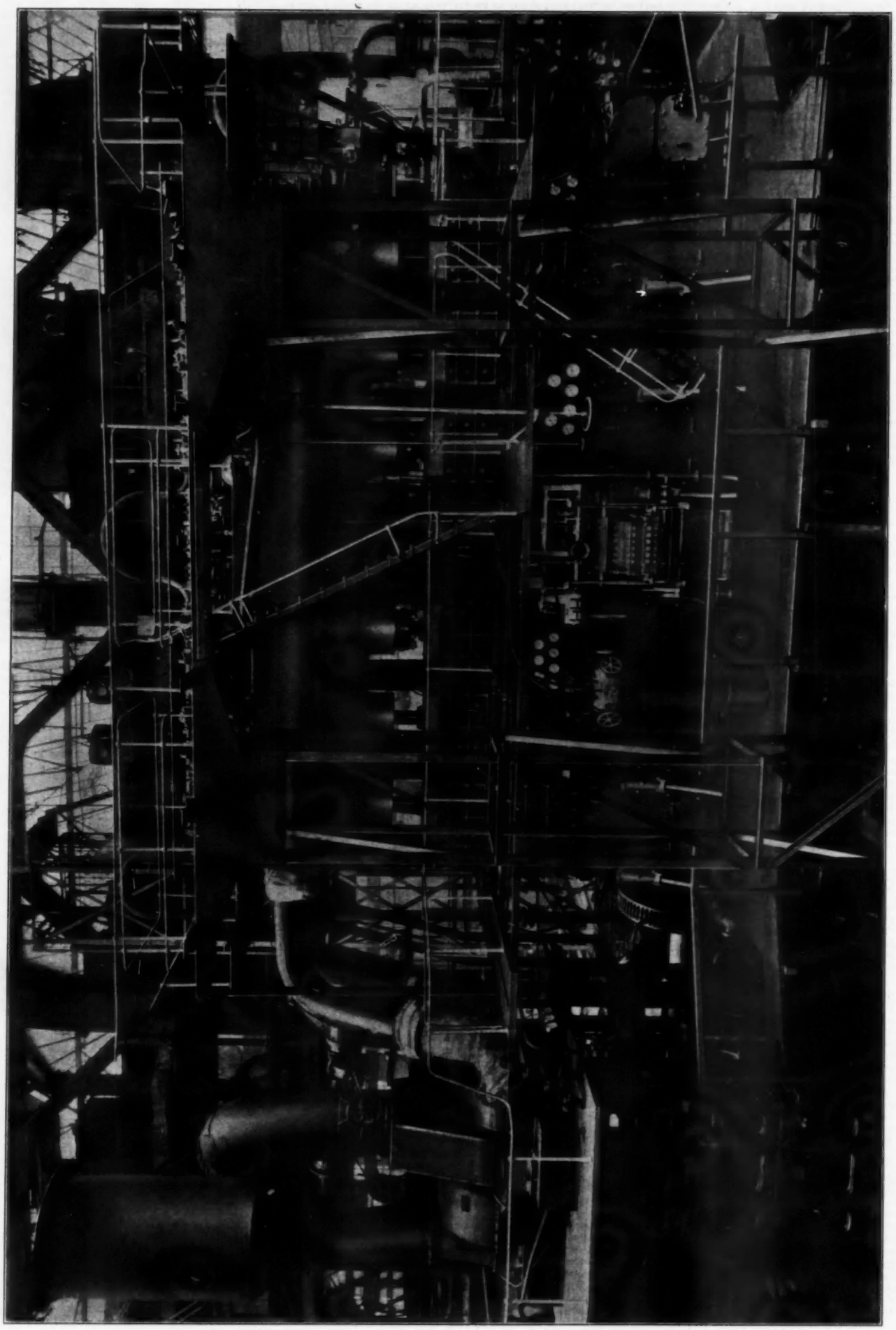

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THE FEBRUARY NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

VOL. CXLIX No. 3868

FEBRUARY 28, 1930.

The British Industries Fair.

SOON after these words appear in print the tenth British Industries Fair will close its doors. It has been stated by the promoters, and is admitted by the exhibitors, both in London and Birmingham, that in all respects it has proved to be the best of the series. The removal of the Metropolitan section from the faded courts of the White City to the enlarged Olympia has raised the Fair to a higher plane, and has encouraged the attendance of a much greater number of visitors than in former years. In the Birmingham section—that in which we are principally interested—the area covered by the buildings at Castle Bromwich has been considerably increased, and further enlargement for next year's Fair is already under consideration. Organised as it is entirely by the Birmingham Chamber of Commerce, with no more than trifling help from the Government, this engineering and hardware section is one of the most remarkable sustained efforts that has ever been made to encourage British industries, and no praise is too high for the successive chairmen and others who have directed its labours. It is not run for a profit, though it pays its way. No unnecessary expense has been incurred on the buildings. The stands are of simple, economical construction. It is not by intention a public exhibition ; no blaring bands make conversation difficult, and no side shows attract a noise-loving crowd. It is entirely a serious affair intended for the prosecution of business. Yet it is daily attracting large numbers, of whom not an inconsiderable proportion pay half-a-crown for admittance. But, as we have said, it is primarily a business affair, and we understand that in that respect the exhibitors are thoroughly satisfied with it.

There are two subjects in connection with the Fair which, ever since its inception, have exercised the attention of the organisers. Of these, the first is the date on which it is held. There can be no question that from many of the home and overseas visitors' point of view a later date, when more clement weather might be expected, would be preferred. As far as the engineering section, which is occupying so much space in our pages, is concerned, a change to April or May would be welcome. But that section fills, possibly, half the total space, the other moiety being taken by the hardware and allied industries. We understand that in these trades it is the practice to place bulk orders early in the year, and they, in consequence, are strongly in favour of the present dates. Since it is very necessary that these industries, whose centre is the Midlands, should be shown every consideration, no means of moving the date into a later month have been found, and as far as we can see, there is little probability under the present conditions of any change in that respect. And as long as the success of the Fair is continued, it will be difficult for those who favour an alteration to advance sufficiently weighty arguments to carry with them those who are satisfied with the present period. The other subject is one of greater importance. Upon it, Mr. G. N. Guest, Deputy Chairman of the Birmingham Chamber of Commerce, to whose constant enthusiasm the Fair owes much of its success, spoke very strongly at a luncheon which was given to the Institution of Mechanical Engineers on Tuesday last. It is the almost total absence of machine tools. We need not remind our readers that the Machine Tool Trades Association holds an exhibition once every four years, and that it prohibits its members from taking part in any other British shows or exhibitions. Our sympathies are with the Association, for the staging of effective machine tool exhibits is a very costly matter. Moreover, we have no right to interfere with its private affairs. But we venture to say that this question is becoming one of national importance. Fortunately, the Fair is British throughout. With the exception of one or two Canadian exhibits, there is nothing whatever in it which, to the best knowledge of the organisers, is not a British product. Hence, to all intents and purposes, no machine tools whatever are exhibited, and we have not to face the lamentable conditions which occurred at a recent London exhibition when German and American firms were able to make very attractive displays and not a single exhibitor was permitted to uphold the British reputation. In this respect the absence of the home machine-tool makers from the Fair is less damaging than from other shows, but at the same time it does seem regrettable that an industry of such vast importance, and one which holds a notable place in the Midlands, should not be represented at a Fair which makes an ever-increasing appeal to British and foreign buyers. Mr. Guest showed substantial reasons why the Association should modify its rule as far as the Fair is concerned. Into them we need not go. The Association is certainly familiar with all the *pros* and *cons* in minutest detail. Indeed, we would not raise the question at all were it not that we cannot but feel, in view of the continually increasing pressure of foreign competitors, that it is almost a problem which can no longer be decided by the convenience of the members of the Association alone, but must be looked at from a national standpoint.

Whilst, as our readers will have gathered from the articles and special supplements which have appeared in this and preceding issues of THE ENGINEER, there is not much in the engineering section which is strictly new, the Show as a whole is a representative one of the characteristic products of the Midlands, with not inconsiderable representation of the manufactures of Sheffield, Glasgow, Bristol, and other centres. The impression it leaves upon the mind is that there is no lack of vitality in the engineering industry, and that it would respond at once to the help that might be given by a wise economic policy. In Birmingham the imposition of a protective tariff may be regarded as the favourite panacea, but even there it is agreed that means of reducing the cost of manufacture must be encouraged if competition in foreign markets is to be met. The manufacturers themselves are doing what they can under very difficult conditions, but they cannot achieve all that they desire, as long as the country is hampered by excessive taxation and high rates. At this serious juncture a policy of economy is needed. Given it, we might safely hope that the natural resilience of the British engineering industry would soon restore it to a sound position.

Pulverised Coal Systems and the Dust Problem.

WHEN pulverised coal firing was first introduced into power stations many of the engineers most

competent to judge held the opinion that if the principle were to be generally adopted it would only be by a development along the lines of what is now known as the unit system. The problems of suitable furnace design and the extra boiler efficiency which the new method of firing might give rise to were common to both the unit and the central system of supplying the fuel. The essential question was therefore to devise some system of preparing and delivering the coal which could compete in simplicity and cost with mechanical stoking. The obvious solution, whatever difficulties might have to be overcome, was simply to replace the stoker by a pulveriser, which would take the raw coal as required and deliver it directly in powdered form to the burners. In the alternative, or central system, the coal was dried, powdered, separated from air, transported, stored and ultimately fed to the burners by apparatus specially provided for each purpose. The system was elaborate and expensive, but its protagonists were powerful. They had also the advantage of being first in the field, and were ready with all kinds of strong arguments as to the necessity of dealing with the fuel in the way they advocated. The central system, therefore, made the earliest headway, but "*la logique a toujours raison*" and the manifest advantages of the simpler system of firing are now becoming generally appreciated. On this point there could be no better evidence than that of the National Electric Light Association of America, which not only calls attention explicitly to the trend of practice in that country, but supports its statement with figures and curves. From these it would appear that of the 1,052,000 square feet of new boiler heating surface equipped for pulverised coal in 1928, 596,000 square feet were fired on the unit system. The progress made during 1929 was very significant. In that year the unit system was applied to no less than 920,000 square feet of boiler surface, out of a total of 1,200,000 square feet, the proportion thus rising from about 57·5 to 76·5 per cent. The strongholds of the central system are, as might be imagined, the large public power stations, though even in these alone the unit system is being applied to something like two-thirds of all the new heating surface brought into commission for pulverised fuel firing. In industrial plants up to less than three years ago the central system retained its initial lead, but it now only holds some 1,550,000 square feet of boiler surface against 2,400,000 square feet served by the unit system. For power station work, on the other hand, the central system seems likely to retain pride of place for some years to come, as, in spite of its more rapid progress, the unit system serves as yet only about 1,600,000 square feet as compared with the 3,250,000 square feet of the central system.

While the battle of the systems thus appears to be in a fair way of settling itself, the statistics alone can throw no light on the technical or commercial reasons for one system being preferred to the other. The essential advantage of the central system consists in the flexibility afforded by the storage of a certain quantity of pulverised coal between the mills and the feeders. If this could be obtained without the difficulties which seem inseparable from the process the victory of the alternative system of direct firing would be much more doubtful. If pulverised coal is to be stored it must first be separated from the air which carries it away from the mill. The universal practice is to pass the coal and air mixture to a cyclone in which the coal is deposited, while the air is returned to the mill by a closed circuit. This would all be fairly simple were it not for the moisture in the fuel. The air tends quickly to become saturated, and unless it is renewed in sufficient quantity the moisture is deposited in the cooler parts of the circuit, mixing with the coal dust to form black mud. A continuous withdrawal of air is therefore required in order to keep the humidity within harmless limits, and this is effected in practice by means of vents at appropriate places. Coal dryers, when used, have also to be vented for obvious reasons. All such air vents, however, are a source of possible trouble. The vented air carries coal dust with it, and though by discharging it into the stack an immediate nuisance may be avoided, such a solution leaves much to be desired. An alternative, employed by the Pennsylvania-Ohio Power and Light Company, is to lead the air vented from the mills into the primary air system of the furnaces, thus avoiding the dust difficulty and at the same time getting some value from its combustion. Even this method is not perfect, as dust settles in the air ducts and has to be blown out periodically; but, on the other hand, it is estimated that no less than 1·5 per cent. of the best pulverised coal is saved. At the Trenton Channel Station of the Detroit Edison Company the nuisance caused by the cloud of coal dust discharged into the air from the cyclone vents has recently been eliminated by equipping each vent with a system of bag filters which retain the dust. The latter is delivered to the main dust conveyors, which carry it to the boiler supply bins. The Milwaukee Electric Railway and Light Company has also recently taken steps to deal with the dust nuisance from the vents. Its plant includes two mills, each grinding 20 tons of coal per hour. The fan in these cases draws air from the cyclone and delivers it to the mill. The systems are vented between the fans and the mills where the pressure is 3in. W.G. Vent air is taken off at the rate of 1300 cubic feet per minute, carrying with it from 100 lb. to 150 lb. of coal dust per hour. This air is passed through an auxiliary cyclone, from the bottom of which the greater part of the coal, together with 300 cubic feet of air per minute, are returned to the mill. The auxiliary cyclone delivers to the atmosphere 1000 cubic feet of air per minute and from 10 lb. to 15 lb. of coal dust per hour. It may be mentioned, for comparison, that the dust-laden air passes from the mill to the cyclone at the rate of 16,000 cubic feet per minute. The other plant of the same company consists of eight 6-ton mills, so arranged that the fans draw from the mills and deliver into the cyclones. The method of venting described above being inapplicable to such a layout, the cyclones themselves were vented centrally, 600 cubic feet per minute of the 6500 cubic feet per minute of the circulating air being drawn off at each cyclone and led to a plenum chamber common to all the eight mills. It was taken from this chamber by a fan, in the suction side of which a water spray was fitted. The fan delivered the mixture into another chamber, from which the air and water vapour escaped to the atmosphere, the coal dust being retained in the form of muddy lumps.

The instances we have quoted indicate some of the methods adopted in various American power stations, apparently with success, to deal with the problem of the coal dust nuisance. That it can be a nuisance, and a very real one, is known to all who are conversant with pulverised coal practice. The unit system of firing reduces it to a minimum, a fact which no doubt contributes in a minor degree to the growing popularity of the system. Much, however, can be done, when the central system is employed, by following the arrangement adopted by the Lakeside Station, in which, except for the short length of pipe connecting the fan discharge to the cyclone, the whole of the air circulating system, including the mill and the cyclone, works under a negative pressure. Such leakage as takes place is therefore from the atmosphere into the system, and dust-laden air has no tendency to escape. Venting, of course, is necessary to keep down the humidity of the circulating air, and this is effected by maintaining the plenum chamber into which the vents discharge at a pressure lower than that at the centre of the cyclone. If the vented air from a cyclone is to be discharged perfectly clean some method of washing, filtering, or electrical precipitation is always necessary, for the experience of the Milwaukee Company shows that without such treatment it is impossible to reduce the coal dust content of the air to less than a quarter of a pound in every thousand cubic feet of air vented. As the minimum quantity of vent air required can be readily calculated from the amount of moisture which has to be disposed of, the proportions of the problem can be determined for any particular case.

The World Engineering Congress in Japan.

(By Our Special Representative.)

No. XI.*

VISITS (*continued*).

YOKOHAMA.

BUT for the insistence of the Japanese in the days when the newly arrived foreign consuls were struggling with the representatives of the Shogunate Government, the port of Yokohama would never have been born. In 1858 a treaty, by which a number of ports were to be opened to foreign trade, was signed, and the consuls, settled in the post town of Kanagawa, insisted on that place being declared an open port. The Japanese, however, insisted on the port being established a mile away, at the fishing hamlet of Yokohama, where there was a natural harbour for shipping, which Kanagawa lacked. Events proved the Japanese to be right, but the consuls were concerned with their motives. Kanagawa was on the high road from the Imperial capital, Kioto, to Yedo, the Shogunate capital, and was constantly traversed by armed samurai, whom the mere sight of a foreigner inspired with the lust to kill. To remove the settlement a mile from the high road, and surround it with a stockade, was the aim of the Japanese, and perhaps there lurked in their minds the fact that in such an inhospitable place the foreign settlement would die a natural death, and the unwelcome foreigners leave Japan, thus solving what was, to the harassed Shogunate Government, a problem of extreme complexity—ever-present, for in the offing were foreign warships, and soon, on the bluff overlooking the new settlement, were to be stationed foreign troops, to remain for twenty years a badge of Japan's servitude, and to provoke, by their presence, internal revolution and continuous attack on foreign life and property.

The port was created—in 1859. The consuls gave way, not without protest, but for once the small foreign commercial element was on the side of the Japanese, for it saw the possibilities of Yokohama, with its natural harbour. What the Japanese saw, however, was something different. They were ignorant of the histories of Singapore, Hong Kong, Shanghai—great ports that have sprung from the jungle, the rock, and the mudflat at the fertilising touch of Anglo-Saxon enterprise, and doubtless they smiled within their beards as they shifted the infant community to the weedy foreshore at the fishing hamlet of Yokohama. The foreign problem was forever disposed of; the foreign settlers would quickly realise the futility of staying longer in a place incapable of providing sustenance.

This attitude of mind was natural. The country had been almost completely cut off from all communication with the outside world for over 200 years. What did the Japanese know of the world without; what could he know? Even to-day, after sixty years of foreign intercourse, extraordinarily distorted ideas prevail with regard to things foreign, and few Japanese will ever understand the psychology of the Western mind.

The settlement must have been a very crowded and busy place. It was there that the Japanese first learned the intricacies of modern commerce, and were certainly the first to appreciate the value to the country of the new export trade, small as it was. According to the guide to Yokohama furnished to the W.E.C. delegates, the area of the town in 1889 was only 2·18 square miles; the stockaded settlement would be smaller than that, and its twisted and narrow streets remained unchanged until the earthquake of 1923.

The post-earthquake development of Yokohama has been carried out with a long eye to the future. The city boundaries have been greatly extended. The area now is 54·25 square miles, one-third larger than Tokio, and the population within these boundaries is 515,000, one-quarter the population of the capital. Within the city limits are enormous undeveloped areas; and the site of the original settlement, the very centre of the port, presents a picture to-day in great contrast to the busy scene of pre-earthquake days, large areas of vacant lots awaiting the builder. But the foundations have been well and truly laid. The harbour works are completed; broad and well-paved streets are ready for the traffic it is hoped will come, and all the machinery of a modern city is in good working order.

Trade is slowly returning. In the first complete trade year, 1860, exports were valued at Yen 578,000, and imports at Yen 543,000. Until the opening of the Suez Canal, trade was almost exclusively with the United States, and even to-day, nine-tenths of the exports go to the States, the largest item, of course, being silk. In the extraordinary development of Japan's foreign trade during the war, the value of exports and imports reached their highest figure in 1919, when the total of Yen 1,700,000,000 was recorded; of which the export share was Yen 1,019,000. Trade to-day is considerably below those figures.

The foreign population of Yokohama at the end of 1926 was returned at 1500 Europeans and Americans and 3500 Chinese and other Orientals. Since then there has been a steady increase of the former, as old business houses are re-established. The foreign position, however, is vastly different from what it was in the early days; even from that of ten years ago. The foreign middleman is not considered essential to trade, as he once was; and Japanese houses are naturally assuming a larger share of the business formerly exclusively in foreign hands. They are now engaged in professions which a few years ago were exclusively conducted by British subjects, such as those of the patent agent and chartered accountant. Conditions are in a state of constant change; affecting the Japanese no less than the foreigner. Keen competition in shipping, in all branches of trade and industry, has superseded the comfortable days of old, when merchants waited for business and the business came, and they grew fat in idleness. To-day, constant effort is necessary to make a bare living, while the

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greatest undertakings are marking time in an era of unprecedented depression.

THE JAPANESE NAVAL PORTS.

Apart from those professionally interested, foreigners, as a rule, have little knowledge of the naval ports of the Japanese Empire—Yokosuka, lying at the end of the peninsula south of Kokohama; Kure, on the Inland Sea; Sasebo, on the west coast of Kyushu; and Maizuru, on the Japan Sea.

The premier port of Admiralty, the first established, is Yokosuka, which is familiar to British subjects as the burial place of Will Adams, of Gillingham, Kent, the first Englishman to set foot on the soil of Japan. Adams was chief pilot of a Dutch fleet which sailed from Holland in 1599 on a trading expedition to Spanish America. The fleet left Peru for Japan, and Adams' vessel was the only ship which arrived. He spent the rest of his life here, practically a prisoner, but honourably treated; took to himself a Japanese wife, no doubt regretting the lady left behind in Old England, but, bowing to circumstances, and during twenty years was a valued servant of the Shogun, his knowledge of shipbuilding, &c., proving of service. His remains lie on a hill overlooking the naval port.

Near Yokosuka also is the monument erected some fifteen years ago to Commodore Perry, U.S.N., at the spot where he landed in 1853 to deliver the letter of President Fillmore, and demand the opening of Japan to trade.

Like many things in Japan, significant of the rush of the people to equip themselves for competition with the Western world, Yokosuka was created, as it were, overnight; it did not grow. A French naval constructor was reponsible for the original designs of works and docks. A glance at the map will show the commanding position of the port, at the entrance to Tokio Bay.

The French officer engaged for this important work, Lieut. Verny, was joined by other officers and mechanics from France, and continued in the Japanese Government service for twelve years, resigning in 1875. Another French officer serving Japan was Captain Bertin, also a naval constructor, who designed two ships subsequently built in England in the late 'eighties, the "Hashidate" and "Chiyoda." Several of the vessels which took part in the Japan–China War in 1894–5 were built at Yokosuka.

A few weeks ago the naval correspondent of the *Daily Telegraph* surprised readers, unacquainted with Japanese naval developments, by his references to conditions at the Kure dockyards. Similarly, on the eve of the Russo-Japanese War, the world, unprepared, was surprised to read of the launching of Japan's first battleship, the "Satsuma," of 18,000 tons, an achievement for those days. Japan had few backers on the eve of the Russo-Japanese War, so well-set do we become in our bogey ideas.

The first vessel built in Yokosuka dockyard was a wooden gunboat, the "Seiki," laid down in November, 1873, launched in March, 1875, and completed in June, 1876. The length of this vessel was 200·5ft., breadth 30·5ft., and draught 13·5ft.; her displacement was 894 tons, indicated horse-power 700, and speed 10 knots. She was wrecked in December, 1888. The largest and by far the most powerful vessel to the credit of the yard is the battleship "Mutsu," now the head of the battle fleet of the Imperial Navy, completed in November, 1921. Her displacement is 32,700 tons. Several of the older battleships and cruisers were scrapped after the signing of the Washington Treaty, and it is impossible to say at this moment what fate awaits the "Mutsu" and her sister line-of-battle ships.

(To be continued.)

OWNERSHIP AND STANDARDISATION OF RAILWAY WAGONS.

THE Federation of British Industries issued this week a memorandum on the ownership pooling and standardisation of railway wagons, in which the recommendations, recently made by the Standing Committee on Mineral Transport, are examined and discussed. The Standing Committee did not recommend the abolition of the private ownership of wagons, but there has been a considerable amount of propaganda in the Press advocating such a change. The Federation, therefore, expresses the view that the present system of wagon ownership should be continued. It holds that no evidence exists to show that the abolition of private ownership would confer any appreciable benefit on any branch of industry. It believes, on the contrary, that such abolition would increase the cost of coal transport, create a shortage of mineral wagons, and dislocate trade. The use of private wagons for the storage of coal, iron ore and limestone is pointed to as a capital reason for the retention of private ownership. The Federation is opposed to the compulsory pooling of wagons on the grounds that it would result in the working of collieries being practically controlled by the railway companies, and because of the difficulties which would arise from the fact that the wagons are not standardised. The Federation is also opposed to the compulsory use of 20-ton wagons, although it is in favour of the standardisation of wagon chassis. It points out that the complete standardisation of rolling stock must be preceded by the standardisation of railway terminals. Private owners, it says, have always advocated the standardisation of wagon chassis and have, in fact, standardised their chassis by agreement with the railway companies. It is found, however, that the companies themselves do not always adhere to the agreed standard. As regards the compulsory adoption of a standardised 20-ton wagon, the Federation holds that the capital expenditure involved in alterations to termini and other works necessary before such wagons could be used, would greatly exceed the £5,000,000 estimated by the Standing Committee on Mineral Transport as sufficient for the purpose.

Literature.

Electric Traction. By A. T. DOVER. London: Sir Isaac Pitman and Sons, Ltd. Price 25s. net. Second edition.

OWING to the fact that since the first edition of this book was prepared electric traction has made considerable progress on railways and railless routes, this new edition of the volume brings the subject up to date, and it contains a vast amount of interesting and instructive information. As far as we know, no other book available in this country at the present time covers such a wide field. All the systems of electric traction employed on railways are considered, and the train equipments, sub-stations, &c., associated with these systems are described. Such matters as the mechanics of train movement, train resistance, and the calculation of speed time curves and energy consumption of electric trains are also dealt with. Considerable attention is paid to traction motors of various types; in fact, no fewer than 128 pages are devoted to this branch of the subject. Similarly, the author has paid much attention to the control of traction motors and the number of pages given to this matter is even greater than the number concerned with the motors themselves. There are innumerable diagrams of connections, most of which are devoid of unnecessary complication, and are fairly easy to understand.

Regenerative electric braking with direct and alternating-current motors is dealt with in a chapter of twenty-five pages. Another chapter discusses the auxiliary electrical equipment for tramcars and trolley omnibuses, and is followed by another on the auxiliary equipment for locomotives and motor coaches. The author then goes on to describe rolling stock for tramways and railless routes and rolling stock for electric railways. To electric locomotives the author allots seventy-two pages, many of which are illustrated. All sections of the book, except those devoted to theoretical considerations, contain a good supply of pictures. Unfortunately, the author seems to have paid most attention to electric locomotives of Continental and American designs. Probably this is mainly due to the fact that British manufacturers have concentrated to a large extent upon the construction of direct-current locomotives, whilst Continental and American manufacturers also build single-phase locomotives and locomotives equipped with motor generators, so that although single-phase current is collected, direct current is supplied to the driving motors. In Italy use is, of course, made of three-phase locomotives, which are also described. Apart from the fact that this section of the book is occupied largely with foreign locomotives, it is quite interesting and instructive, and covers all the electrical schemes at present in use. In fairness to the author, we should mention that he describes engines built by the English Electric Company and the Metropolitan-Vickers Electrical Company, so that it cannot be said that the work of British firms has been entirely neglected.

Following this section on electric locomotives is one on track construction for conduit tramways, as employed on the London County Council tramways. There are also chapters on conductor rails and track work for electric railways, overhead construction for tramways and trolley omnibus routes, overhead construction for railways, feeder and distribution systems and on sub-stations. In the latter chapter the author considers at some length the construction of modern mercury vapour rectifiers, which are gaining considerable prominence on electric traction systems abroad. On the Dutch main line railways and on the Berlin suburban railways all the sub-stations are equipped with rectifiers, and many rectifiers are, of course, found on other traction systems abroad. The sub-station section, which is the last of the twenty-seven chapters that the book contains, naturally also deals with rotary converters, motor converters and motor generators, and with automatic control systems. It is shown that, on account of the simple manner in which a rectifier is started and connected to the direct-current bus-bars, the switchgear for an automatic rectifier plant is much more simple than that for a rotary converter plant.

Although to a large extent the volume is descriptive, it must not be imagined that theoretical considerations have been neglected. Many calculations relating to electrical traction problems are made, and at the end of the book questions are set and answered. Altogether, therefore, the work constitutes a very useful addition to the literature on electric traction, and will no doubt be appreciated by students and engineers.

SHORT NOTICES.

Commercial A.C. Instruments. By G. W. Stubbings. London: Chapman and Hall, Ltd. Price 15s.—Although this book is written primarily for testing engineers and senior students who wish to specialise in the subject of electrical measurements, the author expresses the hope that it will appeal generally to engineers engaged on the technical side of the electrical industry. The theory and practice of the measurement of current, voltage, power, energy, and power factor in alternating-current circuits is dealt with fairly exhaustively, and only such descriptive matter has been included as is necessary for the elucidation of the principles of the method of measurement concerned. The book opens with a short synopsis of elementary alternating-current theory considered with respect to its bearings on alternating current measurements. Three-phase measurements are dealt with at some length. The somewhat difficult conceptions of power factor and volt-ampères in an unbalanced three-phase circuit are illustrated by the method of resolution into symmetrical components. Considerable attention is paid to instrument transformers and the methods of measuring their errors. The methods of, and instruments for measuring reactive power and kilovolt-ampères are considered in detail. In the last chapter the author deals with test-room equipment and gives practical directions for obtaining artificial power factors for testing work. Although the subject is inherently mathematical in character, an endeavour has been made to keep the mathematics as simple as possible. The theoretical matter has been supplemented by practical directions relating to the testing of alternating-current instruments both for accuracy of indication and for correctness of connection after installation. The book should appeal to a large number of people interested in commercial alternating current measurements.

Electric Overhead Travelling Crane Design. By Wilfred A. Barson. London: Crosby Lockwood and Son. Price 15s.—While much has been written on the electric overhead travelling crane, the author of this book contends that a collective work dealing intimately with the design and construction has not hitherto been produced, and the present volume has been written to meet the requirements of those who are interested in this branch of the subject. The book is devoted entirely to peculiarities of design and construction of overhead travelling cranes and repetition of the information to be found in many mechanics and structural text-books has been avoided. The volume is not intended to replace or supersede standard engineering reference or text-books, but rather to supplement them in such a manner as to form a connecting link between the knowledge presented by those books and the actual knowledge required for the competitive design of electric overhead travelling cranes. In the early part of the volume the author deals with general arrangement, and the initial data required for the design of an electric overhead travelling crane. The design of the bridge is then considered. Attention is then paid to the design of the crab. Another chapter deals with limit switches, and is followed by a chapter on electrical equipment. There are also chapters on wiring and load attachments. A collection of tables and charts is also included with a view to facilitating the rapid estimating for electric overhead travelling cranes, and also to serve as a check on finished designs. Although the book only contains 118 pages, it provides the reader with much useful and practical information which can scarcely fail to appeal to those who desire to familiarise themselves with problems associated with electric overhead crane design.

The Practice of Electric Wiring. By D. S. Munro. London: The Electrical Review. Price 4s. 6d.—The third edition of this book is more extensive than its predecessor, and it contains more illustrations. It deals with various kinds of wiring systems and with many practical points associated with wiring work. Like the previous edition, it is written mainly for those who have already had, or are at present receiving, a certain amount of scientific and practical training in applied electricity. The work should appeal to apprentices and students; in fact, even some wiring contractors, particularly those who are not too thorough in their work, might read the volume with advantage. As the author remarks in his introduction, a more detailed study of the difficulties and dangers attending wiring in buildings, ships and mines, and a knowledge of the best methods of meeting them, may restrain the rashness of the cheap contractor or jerry wireman. There are, in all, twenty-seven chapters, which cover a very wide field. Six of them are devoted to various systems, whilst the others cover practically all matters of importance in connection with wiring work.

BOOKS RECEIVED.

The Problem of Oil. By C. T. Brunner. London: Ernest Benn, Ltd., 154, Fleet-street, E.C. 4. Price 15s. net.

Shops, Shed, and Road. By "L.B.S.C." London: Percival Marshall and Co., Ltd., 66, Farringdon-street, E.C. 4. Price 5s. net.

Aircraft Instruments. By C. J. Stewart, D.B.E., &c. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 21s. net.

Sewage and Sewage Disposal. By A. J. Martin, M. Inst. C.E., &c. London: Macdonald and Evans, 8, John-street, W.C. 1. Price 2s. 6d. net.

Unsolved Problems: National and International. By J. S. Hecht. London: Jarrolds Publishers (London), Ltd., 34, Paternoster-row, E.C. 4. Price 16s. net.

Economic Conditions in China. By H. H. Fox, C.M.G., and H. J. Brett, C.M.G. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 2s. 6d. net.

The Design of Merchant Ships and Cost Estimating. Second edition. By Alexander Kari. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 36s. net.

Trials of a 2750 B.H.P. Exhaust Turbo-charged Marine Oil Engine.

By Professor C. J. HAWKES.

We have received from the North-Eastern Marine Engineering Company, Ltd., a copy of a report prepared by Professor C. J. Hawkes, of Armstrong College, Newcastle-upon-Tyne, on tests of the port engine of the Blue Funnel Line motor ship "Maron." The trials referred to were carried out at the builder's Wallsend works on January 3rd, 1930. The principal object of the trials was to ascertain the heat flow to the liners, cylinder heads, and pistons, which was determined by measuring the heat carried away by the cooling media when the engine was operating at constant speed. The normal speed of the engine is 138 r.p.m., corresponding to a piston speed of 1177ft. per minute, but it was decided to carry out the trials at 115 r.p.m., so that the data obtained at the lower would be available for comparison with the results obtained from other engines which were tested by the Marine Oil Engine Trials Committee. In what follows we reprint Professor Hawkes' report in full.

Description of the Engine.

The engine, which is of the four-stroke single-acting type fitted with the Büchi system of exhaust turbo-charging, has six cylinders of 620 mm. (24·4in.) bore and 1300 mm. (51·2in.) stroke. On page 244 we reproduce a photograph of the engine as erected on the test bed.

The nominal power of the engine is 2750 B.H.P. at 138 r.p.m., and the engine has been specially designed to work on the Büchi system at this power. The fly-wheel, which is secured to the after end of the crank shaft, is 3·9ft. in diameter and weighs 2·58 tons. Blast air is supplied by a three-stage compressor, of the steeple type, driven by an additional crank at the forward end of the crank shaft. The compressor is fitted with a piston-rod and crosshead, and the high-pressure cylinder is entirely separate from the low-pressure cylinder—the high-pressure piston being attached to the low-pressure by a rod passing through a gland in the low-pressure cylinder cover.

One fuel pump is fitted for each cylinder. The fuel pump block, which is clearly shown in the photograph, is situated at the front of the engine between Nos. 3 and 4 cylinders. The fuel pumps are actuated from the crank shaft through gearing.

The blower unit, which was manufactured by Brown, Boveri, of Baden, consists of a single-wheel exhaust gas turbine, directly coupled to a two-stage blower. A sectional elevation of the turbo-blower is reproduced in Fig. 1, above.

The main engine has two exhaust manifolds. Nos. 1, 2, and 3 cylinders are connected to one manifold and Nos. 4, 5, and 6 cylinders to the second manifold. These manifolds are led to two separate inlet branches on the exhaust gas turbine casing. There is a common outlet branch from the turbine leading to the atmosphere. The blower discharges the air under pressure into a common main, from which branches are taken to the inlet valves in each cylinder head. Following the usual Büchi practice, the timings of the inlet and exhaust valves are such that there is an appreciable overlap, which results in the scavenging of the cylinder clearance spaces of exhaust gases.

During the shop trials, the turbo-blower was supported on a temporary structure arranged so that the distance of the blower below the air and exhaust mains was about the same as it will be above these mains when it is fitted in the ship, and, as far as practicable, the ship's air and exhaust pipes were used. This arrangement was made with the object of imitating, as closely as possible, the air and exhaust main conditions which will obtain in the ship.

Forced lubrication is employed for the main engine and for the turbo-blower. During the shop trials an electrically-driven forced lubrication pump took its suction from a storage tank and discharged into the oil system through a strainer. After passing through the bearings, the lubricating oil drained from the crank case to the storage tank. A lubricating oil cooler was not in use during the shop trials, but a cooler will be fitted in the ship. Sight-feed lubricators are employed for cylinder lubrication.

The general design of the liners and heads follows the usual North-Eastern Marine practice. In this instance, however, the liner and head of each cylinder are separate castings, the liner being secured to the head by stainless steel studs and nuts, and the whole—viz., the head, joint, and liner—surrounded by the cooling water, which is supplied by an electrically driven pump. Lubricating oil was used for cooling the pistons. The methods employed for measuring the quantities of cooling media passing through the engine are referred to later.

Power Measurements.

During the trials the B.H.P. developed by the engine was absorbed by a Heenan and Froude dynamometer of the compound lever type supplied with water from an overhead tank, in which the level was maintained constant. At the conclusion of the trials, the dynamometer was disconnected from the engine, and balanced, and the necessary dimensions were taken for checking the constant—which is 300. All weights were checked and found correct.

Indicator diagrams were taken from the power cylinders and from the air compressor every thirty minutes. The indicator springs were calibrated before the trials, but there was no opportunity for checking the indicator drives.

Fuel Measurement.

The quantity of fuel passing to the engine was measured by direct weighing. Two tanks were employed, each fitted with a shut-off cock and flexibly connected to a three-way cock in the common suction pipe leading to the fuel pumps. Each tank, of about 17 cubic feet capacity, was placed on the platform of an Avery self-recording weighing machine. At the commencement of a trial one of the tanks was put into communication with the fuel pumps, and the other tank was shut off and filled with oil from the storage tank. The change over from one tank to the other tank was made as necessary during the trial. No heaters were fitted in the fuel system.

The fuel passing to the engine was recorded every 15 minutes. The weighing machines were under the constant supervision of my assistant, Mr. G. F. Hardy, M.Sc., throughout the trials. The machines were checked with standard weights at several points over the ranges covering the fuel measurements and found to be correct. The total leakage of fuel oil from the pump glands during the four trials was 6 lb.

Samples of fuel oil, which were taken during each trial, were forwarded to Messrs. J. and H. S. Pattinson, of Newcastle-on-Tyne, for analysis and for the determination of the calorific value, viscosity, &c. The firm's report is given below.

Carbon	86·77
Hydrogen	12·57
Oxygen	0·14
Nitrogen	0·03
Sulphur	0·49
Ash	None
Water	Trace
	100·00
Specific gravity at 15·5° C.	0·8725
Flash point, close test	90° C. = 194° F.
Soft asphalt	0·03 per cent.
Hard asphalt	0·11 per cent.
Setting point	Quite liquid at −24° C. = −11° F.

Viscosity.	Time of flow of 50 c.c. from Redwood's viscometer in seconds.
At 70° F.	47
At 100° F.	38

	Gross.	Net.
Calories	10,740	10,060
B.Th.U.	19,330	18,110
Lb. of water, evaporated from 100° C. by 1 lb. of the oil	20·0	18·73

Revolutions of the Engine.

The revolutions of the main engine were recorded by a Harding counter. Readings were taken by me every 15 minutes, at the instant the fuel consumption was recorded.

Measurement of Cooling Water.

The jacket-cooling water, on its passage to the engine, passed through a water meter, loaned by the Newcastle and Gateshead Water Company. The water was then led, in series, first to the air compressor cylinder jackets and coolers, then to the piston-oil cooler, and finally to the main engine cylinder jackets. The discharges from the jackets and exhaust-valve housings were led to a common collecting pipe and passed to waste. The water meter was checked at the works of the water company before it was installed and found to be, for all practical purposes, correct. The thermometer used for registering the temperature of the cooling water after it had passed through the air compressor and piston-oil cooler, and before it entered the engine jackets, was placed in the common supply pipe as near as possible to the engine. The outlet temperature was registered by a thermometer placed in the common collecting pipe. Readings of the meter and of the thermometers were taken every 15 minutes.

Measurement of Piston-cooling Oil.

The piston-cooling oil was supplied by a separate electrically driven pump arranged so that it could take its suction, through a strainer, either from two calibrated measuring tanks or from the oil storage tank. The oil discharged from the pump, after passing through a filter and cooler, was led by telescopic pipes to the hollow piston-rods, which were fitted with internal pipes. The oil passed up the rods, on the outside of the internal pipes, to the pistons, returning through the internal pipes to collectors attached to the engine columns. The oil from the collector of each cylinder was led to an inspection trough, which communicated with the common drain pipe leading back to the oil tanks.

For ascertaining the quantity of oil passing through the pistons the pump was put into communication with the measuring tanks, which had previously been filled with oil, and the quantity of oil drawn from the tanks

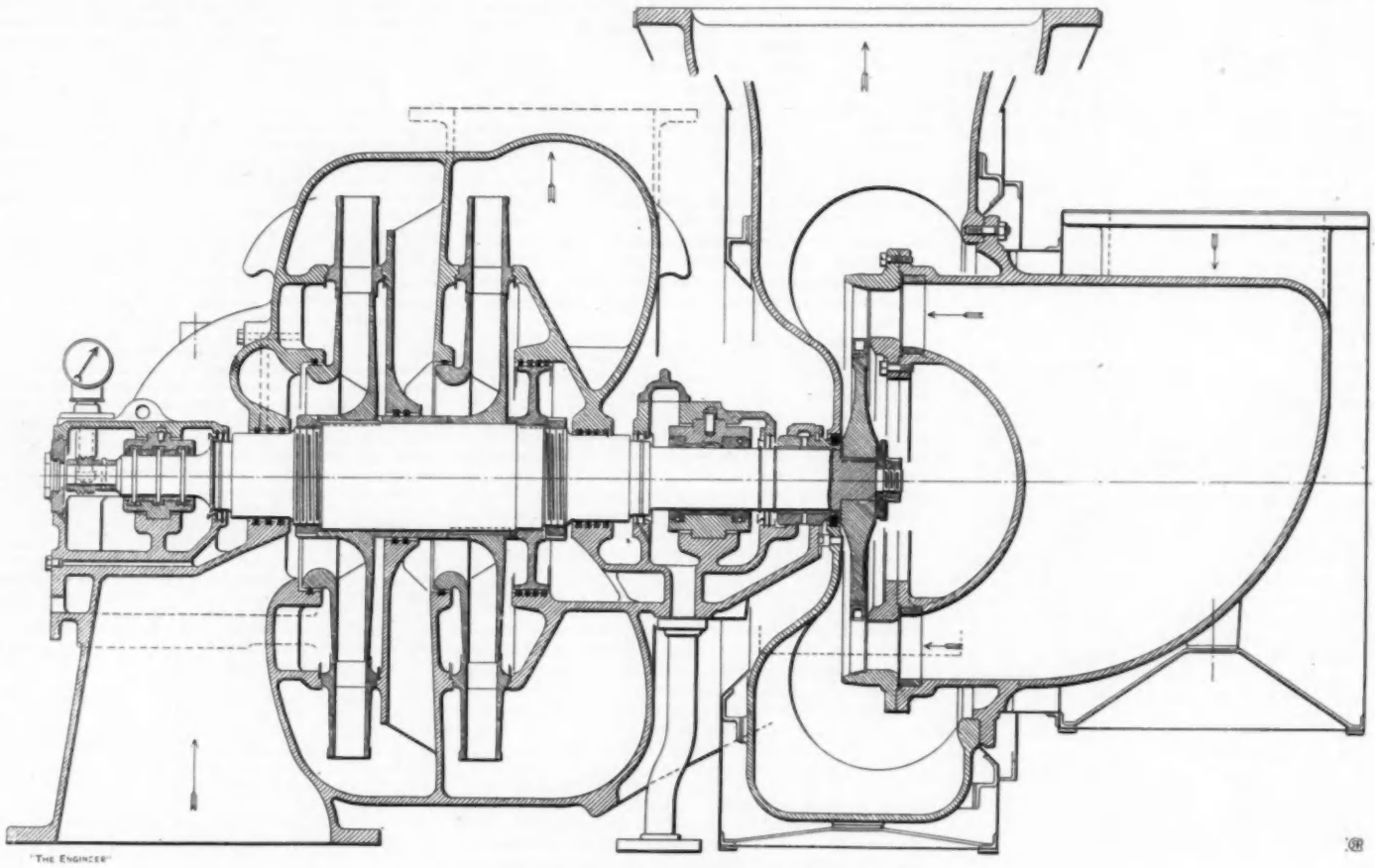


FIG. 1—EXHAUST TURBINE-DRIVEN SUPERCHARGING BLOWER

over a period of about 20 minutes was recorded. Two records were taken during each trial.

The inlet temperature of the cooling oil was taken in the common supply pipe as close as possible to the engine, and the outlet temperature by thermometers placed in the inspection troughs. In the record sheets included in the report the piston-oil outlet temperatures given are the means of the outlet temperatures from the six pistons. These temperatures were taken every 10 minutes.

MEASUREMENT OF AIR.

The blower suction pipe terminated in an enlarged

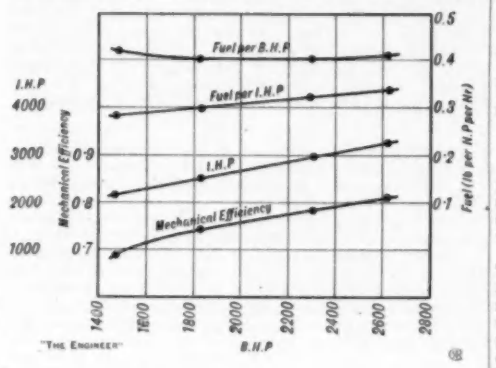


FIG. 2

vertical pipe, about 4ft. diameter and 10ft. in length, in the top end of which was fitted a shaped nozzle, of wood, having a mean diameter of 19·75in. The nozzle coefficient was taken as 0·965. The pressure drop through the nozzle was measured by an inclined-tube manometer, filled with paraffin, which was calibrated before the trials. The temperature of the air entering the nozzle was recorded by a thermometer placed near the top of the enlarged vertical pipe. The pressure in the blower-discharge pipe was measured by means of a U-tube filled with mercury.

A large tank, in which was fitted a throttle plate containing an orifice of 4·503in. diameter, was employed for measuring the air passing to the blast compressor. The coefficient assumed for the orifice was 0·59. The pressure drop across the orifice was measured by means of a manometer filled with paraffin. A thermometer was placed near the orifice for measuring the temperature of the ingoing air. Records were taken every 10 minutes.

EXHAUST-GAS TURBINE.

The pressure of the exhaust gases entering the turbine was recorded by a U-tube filled with mercury. With the object of recording directly the means of the pressures in the two exhaust pipes leading to the turbine a connection was taken from each pipe to a Y-piece, and the common leg of the Y was connected to one limb of the U-tube.

The temperature of the gases entering the turbine were recorded by two iron-constantan thermo-couples and one nitrogen-filled thermometer in *each* inlet pipe. The couples, the leads from which were connected to a multi-point indicator, were calibrated before the trials. The glass thermometers were calibrated after the trials and any necessary corrections have been made in the tabulated results. The means of the readings of the four thermo-couples and the two glass thermometers have been taken as the exhaust temperatures for the purpose of estimating the adiabatic heat drops in the turbine.

The pressure in the exhaust-outlet pipe from the turbine was recorded by a U-tube filled with water. The pressure was found to be approximately atmospheric for all trials. The temperature of the gases leaving the turbine were also registered by two thermo-couples and one nitrogen-filled glass thermometer. The revolutions were recorded by a tachometer driven from the turbine shaft and the records were taken every 10 minutes.

EXHAUST GAS ANALYSIS.

Samples of exhaust gas were taken continuously from the exhaust pipe leading from the turbine. Two samples were taken simultaneously, the total volume withdrawn during each trial being about 10 litres. Each sample was analysed in the works laboratory immediately after each trial, and the mean results are given in Table V. for Trials 2, 3, and 4. The analysis is not given for Trial 1, and the sampling during this trial was considered to be unsatisfactory.

THERMOMETERS.

All thermometers used for recording the temperatures given in this report were calibrated after the trials, except where otherwise stated.

RECORDS.

The water and air measurements, the pressures and the temperatures were recorded by six senior students of Armstrong College. The indicator diagrams were taken by the North-Eastern Marine Engineering Company's record staff.

TRIAL RESULTS.

Four one-hour trials were carried out at brake mean pressures of 69·9 lb., 88·2 lb., 110·3 lb., and 125 lb. per square inch. The engine was run at the trial load for a sufficiently long period before each trial was commenced to ensure that stable conditions had been reached.

The principal records and deductions are given in Tables I. to VI., and in the curves reproduced in Figs. 2, 3 and 4. In Fig. 2 the I.H.P., fuel per H.P., and mechanical efficiency are given on a B.H.P. base. Fig. 3 shows the fuel per hour, mean indicated pressures, compression pressures and gas temperatures at the turbine inlet, drawn on a brake M.E.P. base; while Fig. 4 indicates the heat to liners, heads, and exhaust valve housings, heat to pistons, blower air discharge pressure and exhaust turbine inlet pressure, drawn on a B.M.E.P. base.

A typical indicator diagram taken during the trials is reproduced in Fig. 5, with the engine running at 115·6 r.p.m., the B.M.E.P. was 125 lb. per square inch, the M.I.P. 154·0 lb. per square inch, and the total B.H.P. 2620.

In Table III. the " B.Th.U. per square foot of surface per hour " to the liners and heads have been obtained by dividing the total heat to the cooling water by the total surface of the liners and heads, assuming that the heads are plane surfaces and that the exposed liner surfaces are cylindrical, of length equal to the stroke, plus the clearance volume divided by the piston area. As already mentioned, the head and liner of each cylinder are surrounded by a continuous water jacket, and it was not possible, therefore, to separate the heat to the heads from the heat to the liners. Moreover, the total heat to the cooling water includes the heat transmitted through the exhaust valve housings—which could not be separately measured—consequently, the average heat transmissions per square foot of liner and head surface, given in the table, are slightly higher than the actual figures.

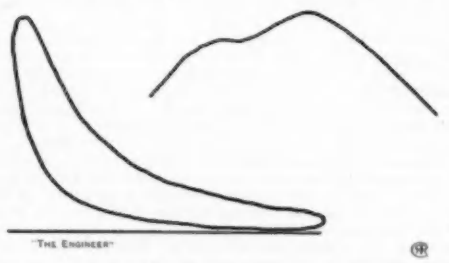


FIG. 5—A TYPICAL INDICATOR CARD

In calculating the average " B.Th.U. per square foot per hour " to the pistons, it has been assumed that the pistons are plane surfaces. The average specific heats of the lubricating oil used for piston cooling, over the ranges of temperature given in Table III., vary from 0·4 for Trial 1 to 0·412 for Trial 4.

Mercury-in-steel thermometers were placed in the exhaust branch from each cylinder, and the mean readings are given in Table V. for record purposes, as these thermometers will be in use when the engine is in the ship. The readings of these thermometers are not the true mean temperatures of the gases in the exhaust pipes, and must be regarded of value for comparative purposes only. At the turbine inlets the gases would approach a uniform mixture, although the mixture would probably not be complete. It was for this reason that two thermo-couples and one glass thermometer were placed in each exhaust pipe, adjacent to the turbine inlet branches, and the means of the readings of the couples and thermometers were taken, as already mentioned, as the mean exhaust temperatures for calculating the adiabatic heat drops in the turbine.

TABLE I.—*Powers and Fuel Consumptions.*

	Trial number.			
	1	2	3	4
Duration, minutes	60	60	60	60
Brake load, lb.	3800	4800	6000	6800
B.M.E.P., lb. per sq. in.	69·9	88·2	110·3	125
Average r.p.m.	117·2	115·3	115·7	115·6
B.H.P.	1485	1845	2314	2620
I.H.P.	2145	2465	2935	3230
Mechanical efficiency, per cent.	69·2	74·8	78·8	81·1
Total fuel per hour, lb.	612	740·5	926·5	1066
Fuel per I.H.P. per hour, lb.	0·29	0·3	0·32	0·33
Fuel per B.H.P. per hour, lb.	0·412	0·401	0·4	0·407
Thermal efficiency on B.H.P. basis, taking H.C. value of fuel, per cent.	32·0	32·8	32·9	32·3

Any error in the mean gas inlet temperature would affect the adiabatic heat drop in the turbine; but if the maximum reading obtained in Trial 4 be taken as the gas temperature, instead of the mean of the readings of all the thermometers which is given in Table V., the isothermal work and the adiabatic work of the blower expressed as percentages of the adiabatic heat drop in the turbine would only be reduced from 47·5 and 49·3 to 46·6 and 48·4 respectively. It should be mentioned that the variations in the readings of the thermo-couples and the thermometers were less in Trials 1 to 3 than in Trial 4.

A heat balance, based on the higher calorific value of the fuel, is given in Table VI. Owing to the large quantity of water which was passed through the jackets and coolers of the blast air compressor, and the consequent small rise in temperature and the possible large errors in estimating the heat rejected to the water, the " heat to compressor " has not been included as a separate item.

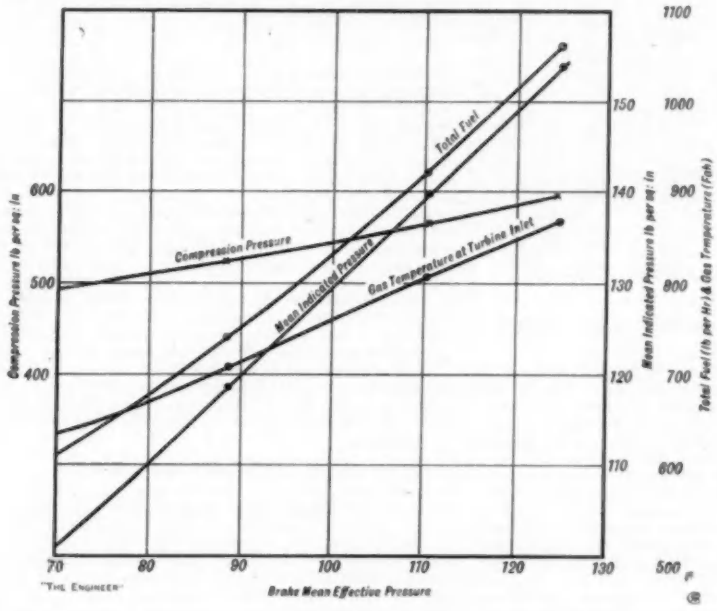


FIG. 3

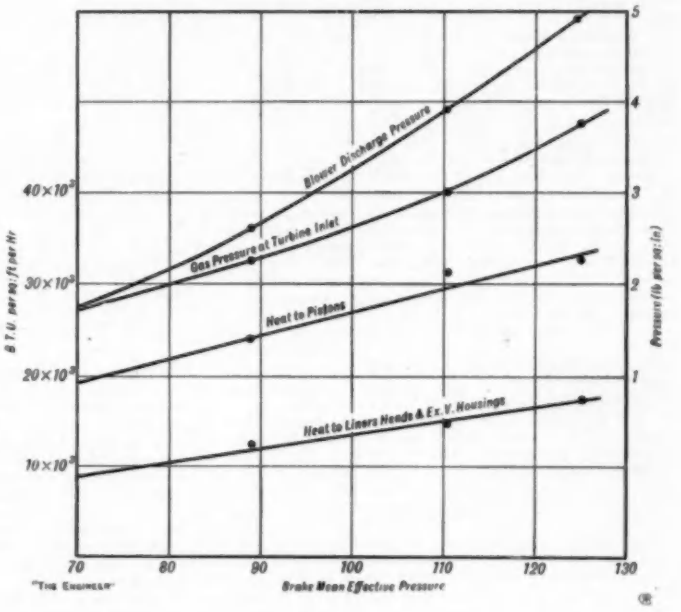


FIG. 4

TABLE II.—*Average Cylinder Pressures.*

	Trial number.			
	1	2	3	4
B.M.E.P., lb. per sq. in.	69·9	88·2	110·3	125
M.I.P., lb. per sq. in.	101	118	140	154
Compression pressure, lb. per sq. in.	496	521	562	595
Maximum pressure, lb. per sq. in.	588	623	665	694

CONCLUSIONS.

As will be seen from Table I. and Fig. 2, the fuel consumption per B.H.P. did not vary to any appreciable extent throughout the trials. In this connection it should be mentioned that the engine had been running at 138 r.p.m. during the official acceptance trials on January 2nd, 1930. The trials referred to in this report, which took place on the following day, were run at 115 r.p.m., with the fuel cam settings arranged for a speed of 138 r.p.m., as there was no opportunity to adjust the fuel cams to suit the lower speed.

The exhaust gases during Trials 1, 2, and 3 were colourless. Owing to darkness, it was not possible to see the end of the exhaust pipe during Trial 4, but from test-cock observations the gases appeared to be clear.

The difference between the air pressure in the blower discharge pipe and the mean pressures in the exhaust

pipes increased from 0·05 lb. per square inch in Trial 1 to 1·2 lb. per square inch in Trial 4. One would expect, therefore, that the "negative work" or "pumping loss" would be slightly greater in Trial 1 than in Trial 4. Light-spring diagrams, which were taken during the trials, showed that the negative work did decrease with an increase in the brake mean pressure, but the change was not very marked. The negative work during each trial, however, was less than that usual with non-supercharged, four-stroke engines.

TABLE III.—*Cooling Circuits.*

	Trial number. 1	2	3	4
Liners, heads and exhaust valve housings :				
Cooling water, lb. per hour	75,200	86,000	86,100	98,000
Inlet temperature, ° F.	52	51·8	52·8	52·1
Outlet temperature, ° F.	78	80·2	85·7	86·5
B.Th.U. per hour, total	$1·955 \times 10^6$	$2·44 \times 10^6$	$2·83 \times 10^6$	$3·37 \times 10^6$
B.Th.U. per B.H.P. per hour	$13·16 \times 10^2$	$13·2 \times 10^2$	$12·2 \times 10^2$	$12·86 \times 10^2$
B.Th.U. per sq. ft. per hour	$9·89 \times 10^3$	$12·3 \times 10^3$	$14·3 \times 10^3$	$17·05 \times 10^3$
Pistons :				
Cooling oil, lb. per hour	17,580	20,650	24,050	23,280
Inlet temperature, ° F.	62	64	63	67
Outlet temperature, ° F.	116	120	126	132
B.Th.U. per hour, total	380×10^3	463×10^3	607×10^3	623×10^3
B.Th.U. per B.H.P. per hour	$2·56 \times 10^2$	$2·51 \times 10^2$	$2·62 \times 10^2$	$2·38 \times 10^2$
B.Th.U. per sq. ft. per hour	$19·5 \times 10^3$	$23·8 \times 10^3$	$31·2 \times 10^3$	$32·0 \times 10^3$

TABLE IV.—*Turbo-blower and Blast Air Compressor.*

	Trial number. 1	2	3	4
Blower :				
Air inlet temperature, ° F.	59	58	56	57
Air discharge temperature, ° F.	85	93	107	121
Barometer, lb. per sq. in.	14·45	14·48	14·48	14·48
Discharge pressure, lb. per sq. in. absolute	16·21	17·07	18·37	19·4
Capacity of blower, lb. per sec.	7·32	8·16	9·10	9·85
Blower air per lb. of fuel, lb.	43·0	39·6	35·325	33·225
Isothermal work per lb. of air, B.Th.U.	4·11	5·85	8·45	10·4
Adiabatic work per lb. of air, B.Th.U.	4·18	6·0	8·68	10·8
Blast air compressor :				
Air inlet temperature, ° F.	54·5	53·5	54·3	53·7
Air per second, lb.	0·457	0·5	0·51	0·51
Air per lb. of fuel, lb.	2·7	2·4	1·975	1·725
Blast pressure, lb. per sq. in.	900	950	1000	1000
Total blower and blast air passing through engine per lb. of fuel, lb.	45·7	42·0	37·3	34·95

The rated power of the engine of the "Maron" is based on a B.M.E.P. of 110 lb. per square inch, corresponding to Trial 3. For the purpose of comparing the heat transmitted through the liners, heads and pistons of this engine with other four-stroke engines, not supercharged, for which authoritative data are available, Table VII. has been prepared from the published results of the trials of the six-cylinder engines of the "Sycamore" and "Cape York," which were tested by the Marine Oil Engine Trials Committee of the Institution of Mechanical Engineers and the Institution of Naval Architects.

TABLE V.—*Exhaust Gases and Exhaust Turbine.*

	Trial number. 1	2	3	4
Thermometer readings :				
Turbine inlet, ° F.	635	705	803	867
Turbine outlet, ° F.	590	662	738	803
Cylinder exhaust branches, ° F.	608	621	694	757
Pressures :				
Turbine inlet, lb. per sq. in.	16·16	16·7	17·49	18·21
Turbine outlet, lb. per sq. in.		Atmospheric		
R.P.M. of turbine and blower	2530	3000	3565	4000
Percentage composition of dry exhaust gases, by volume, CO_2	—	4·45	5·15	5·95
CO	—	0·75	0·6	0·6
O_2	—	13·45	12·6	11·7
N_2	—	81·35	81·65	81·75
Mean specific heat of gases, B.Th.U.	0·252	0·252	0·254	0·256
Mean value of adiabatic exponent	1·377	1·375	1·371	1·367
Adiabatic temperature drop, ° F.	33	44·4	63	79
Adiatatic heat drop in turbine per lb. of gas, B.Th.U.	8·3	11·2	16·0	20·23
Exhaust gases per lb. of fuel, lb.	46·7	43·0	38·3	35·95
Isothermal work in blower				
Adiabatic drop in turbine, per cent.	45·6	48·1	48·7	47·5
Adiabatic work in blower				
Adiabatic drop in turbine, per cent.	46·4	49·4	50·0	49·3

TABLE VI.—*Heat Balance in Units of* 100 *B.Th.U. Per Minute.*

	Trial number. 1	2	3	4
Heat in fuel, higher calorific value	1970 (100)	2385 (100)	2985 (100)	3435 (100)
Thermal equivalent of B.H.P.	630 (32·0)	783 (32·8)	981 (32·9)	1111 (32·3)
Heat to liners, heads and exhaust valve housings	326 (16·6)	407 (17·1)	472 (15·8)	562 (16·4)
Heat to pistons	63 (3·2)	77 (3·2)	101 (3·4)	104 (3·0)
Heat to compressor, exhaust gases, &c. (by difference)	951 (48·2)	1118 (46·9)	1431 (47·9)	1658 (48·3)

NOTE.—Numbers in brackets are percentages, to the nearest first place of decimals.

It will be seen that the heat to the liners, heads and exhaust valve housings, and the heat to the pistons, per square foot of surface per hour, are about the same in the engine of the "Maron" as in the engine of the "Cape York." In the engine of the "Sycamore," the heat to the liners, heads, and exhaust valve housings—per square foot of surface per hour—is slightly greater, and the heat to the pistons—per square foot of surface per hour—is appreciably less, than in the engine of the "Maron." The heat to the jacket-cooling water, however, includes a certain amount of heat which has been transmitted from the pistons to the liners, and this may be greater in one design than in another. In the circumstances, therefore, I am of opinion that a better comparison is obtained by dividing the total heat to the liners, heads,

TABLE VII.

Engine	"Maron"	"Sycamore"	"Cape York."
Trial number	3	5	10
Bore, in.	24·4	24·41	22·05
Stroke, in.	51·2	38·39	39·37
Compression ratio	12·28	13·01	14·39
Mean indicated pressure, lb./in.²	140	94	108
Brake mean pressure, lb./in.²	110·3	73·5	71·7
R.P.M.	115·7	118·8	125·1
Brake horse-power	2,314	1,188	1,018
Fuel per hour, lb.	926·5	537·3	427
Heat to liners, heads, and exhaust valve housings :			
B.Th.U. per sq. ft. per hour	14,300	15,600	14,100
B.Th.U. per B.H.P. per hour	1,220	1,994	1,910
B.Th.U. per lb. of fuel per hour	3,060	4,410	4,550
Heat to pistons :			
B.Th.U. per sq. ft. per hour	31,200	19,500	33,000
B.Th.U. per B.H.P. per hour	262	318	519
B.Th.U. per lb. of fuel per hour	655	703	1,236
Heat to liners, heads, exhaust valve housings and pistons :			
B.Th.U. per sq. ft. of area of liners, heads, and pistons, per hour	15,800	16,000	16,800

and pistons by the total area of the surfaces exposed to the working fluid. These figures are shown on the last line in Table VII. It will be noted also that the heat to liners and heads and to pistons, per B.H.P. per hour and per lb. of fuel per hour, are lower in the turbo-charged engine than in the engines of the "Sycamore" and "Cape York." These results indicate that the heat transmitted to the cooling surfaces—and, other things being equal, the heat stresses in the material—are no greater in the turbo-charged engine than in the engines which are not turbo-charged, when the former is developing a brake mean effective pressure about 50 per cent. greater than the latter.

The engine of the "Maron," which was under my constant supervision, ran smoothly and steadily throughout the trials, without an incident of any kind.

(Signed) C. J. HAWKES.

February 8th, 1930.

Books of Reference.

"THE Mercantile Year Book and Directory of Exporters in London, Manchester, Liverpool, Birmingham, Glasgow, Bradford, &c., and Foreign Centres, 1930." London: Lindley-Jones and Brother, Ltd., 32, Bishopsgate, E.C. 2. Price 20s.—This book of reference, in accordance, we are told, with a generally expressed desire, appears this year considerably earlier than usual. Its plan and contents are, in the main, those rendered familiar to business men by the forty-three forerunners of a book founded in 1887 and still edited by the founder, Mr. W. Lindley-Jones. An uncommonly large number of changes have, however, been made in this year's issue. It is claimed for the work that it is unique in that it combines a carefully verified list of the names of merchant shippers in Britain and neighbouring countries, with the names of the importers overseas for whom those merchants act. Doubtless the present issue will be as well received as those which have gone before it.

"THE *Mechanical World* Electrical Pocket Book, 1930." Manchester: Emmott and Co., Ltd., *Mechanical World* Office, 65, King-street; and London: 20 Bedford-street. Price 1s. 6d.—This, the "younger brother" of the *Mechanical World* Year Book—it is now twenty-three years old—while it embodies all the various sections contained in those which have gone before it, has evidently been thoroughly brought up to date. The sections dealing with lighting circuits and switching have been entirely revised, while those concerning lamps and lighting have been rewritten. Much of the matter in the early sections has also been rewritten and extended to cover direct-current generators and motors, synchronous, induction, auto-synchronous and synchronous-induction, and traction motors. Further additions include data relating to condenser calculations and various new tables of a miscellaneous character. A most useful little book.

"THE *Mechanical World* Year Book, 1930." Manchester: Emmott and Co., Ltd., *Mechanical World* Office, 65, King-street; London: 20, Bedford-street, W.C. 2. Price 1s. 6d. net.—In this, the forty-third edition, the sections on Steam Engines, Steam Turbines, Condensers and Rope Driving have, we are told in the preface, been carefully revised and rewritten. The latest steam tables have also been incorporated. All the usual features appear to have been retained, and undoubtedly the little volume will be found to be every bit as useful as its predecessors.

"THE Blue Book, 1930: The Directory and Handbook of the Electrical Engineering and Allied Trades." London: Ernest Benn, Ltd., Bouverie House, Fleet-street, E.C. 4. Price 25s.—The "Blue Book" appears this year in its forty-eighth consecutive edition, and is, naturally, so well known that no word of introduction from us is needed. It is a work to which we are constantly appealing for information, and very rarely indeed do we refer to it in vain. Its collection of tables is a great feature of the book, for it covers such a wide area, and the conversion table is always coming in handily. There are all the usual features, and, in addition, there is a fund of new information.

"THE South and East African Year Book and Guide for 1930," edited annually for the Union-Castle Mail Steamship Company, Ltd., by A. Samler Brown, F.R. Met. S., and G. Gordon Brown, F.R.G.S. London: Sampson Low, Marston and Co. Price 2s. 6d.—Among features of interest to engineers which appear in this year's issue are plans of the African Harbours touched at by the Union-Castle Company's boats. There are also articles on the "Development of Power Farming" and the "Iron and Steel Industry." Beyond these there is a mass of information calculated to be of use to business men; imigrants and settlers; sportsmen; tourists, &c. The book is well printed and got up, and there is a series of excellent coloured maps. Altogether, it is likely to prove a most useful book of reference for anyone proposing to visit South or East Africa.

"SPECIFICATION." For Architects, Surveyors, Civil Engineers and for all Interested in Building. Edited by Frederick Chatterton, F.R.I.B.A. London: The Architectural Press, 9, Queen's-gate, Westminster, S.W. 1. 1930. Price 10s. 6d.—In this year's issue—the thirty-second—considerable alterations have been made in the twenty-eight trade sections which comprise the greater part of the book. Much new technical information has been added, and it is claimed that great gain to the volume has resulted therefrom. New technical articles in the sections dealing with heat-excluding glass, ultra-violet ray glass, artificial daylight, the cleaning of stonework, &c., have been incorporated; while the new articles embodied in the current issue are:—"The Planning of Modern Theatres and Cinemas," by W. G. Wilson, F.R.I.B.A., and J. W. Gilmour Wilson, A.R.I.B.A.; "Motor Garages," by C. W. Glover, Assoc. M. Inst. C.E.; "Acoustic Properties in Building Work," by "An Acoustical Engineer"; "The Design and Construction of Tall Chimneys," by W. C. Andrews, Assoc. M. Inst. C.E.; and "Oil as a Domestic and Central Heating Fuel," by "A Specialist."

Electric Heating.

AT the E.D.A. conference held at the British Industries Fair at Castle Bromwich on Thursday, February 20th, 1930, Mr. R. Alan S. Thwaites opened a discussion on "Electric Heating for all Purposes, with special reference to Water Heating." The potential load of this country, Mr. Thwaites explained, was estimated to be in the neighbourhood of ten times the total load at present connected to the public supply systems. In the case of many applications the advantages of electricity were so great that prices in line with those prevailing for motive power could be obtained. But like every other kind of load, if it were desired to obtain the whole load the price for certain applications must be very low. It was well to consider, therefore, how low a price the supply industry could justifiably offer and to what extent restrictions as to use could be made to assist in that respect.

The price provisionally quoted by the Central Electricity Board to supply undertakers for supplies in the neighbourhood of 10,000 kW and upwards—commonly known as "grid price"—varied somewhat for different electricity areas, but averaged about £3 per kVA per annum plus 0·2d. per unit. Seeing that at an early date all supply authorities in Great Britain would be purchasing the whole of their current either directly or indirectly from the Board, it was convenient to take that as a basis on which to make a few simple calculations. The price resulting from the tariff at different load factors was shown in the curve on the next page.

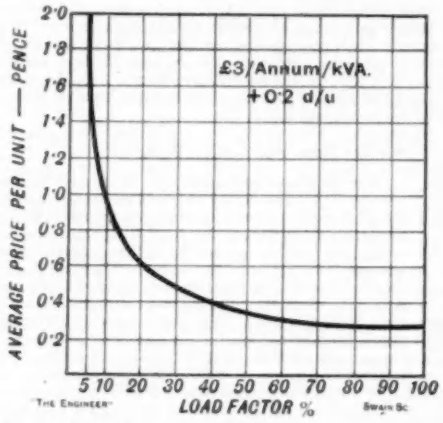
Considering first entirely "off peak" load, the current cost the supply authority 0·2d. per unit, and in order to include a contribution towards the expense of distribution and management together with a profit—which in the "grid price" were included in the standing charge—the usual figure offered to-day for large "off peak" supplies was 0·3d. per unit to 0·35d. per unit. Where, on the other hand, the heating load was not restricted as to times of use, then that load must bear a due proportion of the standing charges, both on generation and distribution. Referring to the curve, it would be found that at, say, a 20 per cent. load factor, the cost of current at "grid price" was 0·63d. per unit. To that must be added a proportion of distribution charges, management and profit. On the other hand, diversity came to the engineer's aid—often to a considerable extent—with the result that the load factor

of a group of heating supplies might be high, although the load factor of individual supplies might be comparatively poor. It was not to be overlooked, however, that as the individual load factors improved, so the diversity diminished, and at 100 per cent. load factor there could be no diversity. In that connection, it would be noted from the curve that the resulting average price per unit from the grid tariff at 100 per cent. load factor was 0·28d. per unit, but that was to be regarded merely as the cost of generation or its equivalent.

In order to sell current for heating purposes cheaply, it was essential to arrange matters so as to improve the load curve of the system. Suppose, by making suitable arrangement it were possible to obtain a level load on the system day and night—*i.e.*, to obtain 100 per cent. system load factor. What then? In the first place, there would be no more "off peak" available units until additional load for other purposes had been obtained, and, secondly, the consumers for lighting and motive power purposes would expect to share in the benefit resulting from the low cost of generation brought about by the high load factor on the system. At Berne in Switzerland the load factor had already been reached about 90 per cent., owing to the growth of heating load, with the result that the time of the "peak" now tended to move about. Accordingly, it was the duty of certain officials periodically to alter the time switches controlling various heating supplies so as to keep the "peak" under control. Certain supply undertakings were inclined to the belief that if they could obtain a little more than their coal cost for current for heating purposes, they were doing quite well, but that point of view was unsound, and it was necessary to have regard to the other considerations.

An interesting application in regard to heating was the heat pump, and results of tests on plant in operation were given in a paper recently read by Mr. T. G. N. Haldane before the Institution of Electrical Engineers. The principle of the heat pump was well known. It was a reversed cycle heat engine, and, owing to the thermal operation, by drawing heat from the atmosphere, it was possible to send out far more heat than was equivalent to the electrical energy supplied to the pump. The application was at present mainly of scientific interest, but it was possible that practical development would follow.

Here Mr. Thwaites exhibited a number of lantern slides, indicating the growth of industrial heating load based on



PRICE PER UNIT WITH VARYING LOAD FACTOR

information prepared by the Industrial Heating Committee of the National Electric Lighting Association of America. One of these slides showed the comparative rate of growth of different classes of load in the case of fourteen large electricity supply undertakings in America taken together, and showed that in four years the heating load had increased by 104 per cent. For the year 1928 the heating load represented some 6 per cent. of the total load, whereas in 1924 it was 3 per cent. It was therefore still a relatively small but rapidly growing proportion. Another slide showed the growth in the case of one of the supply companies which has developed the industrial heating load more actively than the average, and in the year 1928 the units sold for industrial heating processes reached 21 per cent. of the total load. It was estimated, Mr. Thwaites explained, that in 1929 no fewer than 6000 million units were sold in the United States for industrial heating processes. It seemed clear, the speaker went on to state, that the sales organisations could devote considerable attention to obtaining heating load in this country, and particularly in industrial areas. In that respect the Birmingham supply undertaking had been particularly successful, and those responsible were to be congratulated for their enterprise.

The electricity supply industry fully understood that a mere comparison of heating sources on a thermal basis meant nothing without a complete investigation of the total costs. In many heating processes the heat applied to the intended purpose was small compared with the total heat supplied. To take an extreme case: A metallurgist required to heat 10 grammes of a substance to 1000 deg. Cent. for a period of one hour. The heat absorbed in raising the temperature of that quantity of material was minute. The process was usually carried out in a muffle furnace weighing many pounds. Sufficient heat had to be applied not only to heat the crucible and its contents, but to raise the temperature of the muffle furnace and also to make up for the heat losses while maintaining the temperature. The use of electricity for heating enabled furnaces to be so designed as to result in a high efficiency of utilisation. Electric heating was particularly advantageous when intermittent heat was required. The indirect advantages were fairly well known, at any rate to the supply industry, but it was perhaps worth enumerating a few of them:—Automatic control reduced labour in operating; a higher grade product was obtainable; there were fewer spoilt articles; there was no fuel or ash handling and no chimneys, and no flues or fuel bunkers to provide; the operators also worked under comfortable conditions.

The heating of large buildings by means of a system of thermal storage appeared to be quite practicable with current at approximately 0·35d. per unit for "off peak" use. In that connection there seemed to be considerable scope for reducing the heat losses from buildings by taking special precautions in their design and construction. The heating of water was possibly the greatest immediate application in the home. The most recent tests on a large scale appear to be those which had just been published by the Detroit Edison Company, and which appeared in an article by Mr. Harry A. Snow in the *Electrical World* of January 11th, 1930.

The figures had been obtained by aggregating the load curves of 1000 electric water heaters so as to obtain the effect on the power station of such a load. Tests had been taken under service conditions on water heaters installed in typical homes in rather moderate circumstances. A lantern slide showed the average annual consumption of different appliances in the home, and indicated that the load to be expected from water heating averaged approximately double that taken by an electric cooker. It seems to be the general experience that for a moderate size of house sufficient hot water would be available if the number of gallons of water in the water heater multiplied by the maximum rating in kilowatts was approximately 60. Thus, if a 2-kW heater was used the tank should hold 30 gallons; if a 3-kW heater, 20 gallons, and so on.

Another slide showed the average daily load produced by 1000 electric water heaters, and indicated that the maximum load was 750 kW or ¾ kW per heater.

The maximum load on wash-day rose to just over 1300 kW, or 1·3 kW per heater, but the peak occurred during the morning, and did not therefore coincide with the evening lighting peak.

A slide showed how the average figure of 2825 units per annum was made up month by month. The heaters which were tested were mostly so interconnected with the coke furnaces on the various premises that a certain amount of heat in the winter time was obtained from that source, and that explained the higher consumption during the summer than in the winter. That, the speaker explained, suited supply undertakings very well, as it tended to level out their annual load curve.

Another slide showed the load curve produced by 1000 water heaters in which the ratio of gallons to kilowatts was 4, the average conditions probably being something like 16 gallons and 4 kW. The peaky nature of the load curve was very marked, but, even so, the combined load factor of 1000 heaters was 49 per cent. A similar curve was exhibited for 1000 low-capacity heaters, probably on the average about 1½ kW and 40 gallons. The load curve in that case was far more smooth, and the combined load factor as high as 73 per cent. The load between 4 and 6 p.m.—which for most undertakings is the time of "peak" load—was nearly double that taken during the same period by highly rated water heaters. That result might at first sight seem surprising, but further consideration of the circumstances enabled one to realise the reason, namely, that with the highly rated water heaters the hot water used for washing up after luncheon was made up fairly rapidly, whereas with the low-capacity heaters it was not.

South African Engineering Notes.

Building Boom.

In the last few years there has been great building activity throughout the Union, and in practically all the leading centres the peak was reached during the year ended June 30th, 1929. The following comparisons for the year, between several of the leading towns—the number of plans being given first and the value of the buildings they represent coming next—are interesting:—Bloemfontein, 325 and £342,625; Johannesburg, 6625 and £3,258,148; Pretoria, 830 and £1,031,660; Kroonstad, 52 and £36,700; Durban, 1547 and £972,955; East London, 463 and £263,792; Port Elizabeth, 460 and £675,581; Kimberley, 277 and £102,748. For the year ended June 30th, 1928, plans to the value of £5,742,958 were passed in the Cape Province, £4,742,751 in the Transvaal; £789,688 in Natal; and £654,178 in the Free State. In spite of this great building activity, the demand for carpenters, bricklayers, and stonemasons is actually decreasing, in consequence of the revolution which is taking place in the materials used for building. Cement and reinforced concrete are superseding bricks, stone, and mortar, and therefore fewer skilled layers of bricks and stone are required. The quantity of unskilled labour required is also reduced, as the concrete is mechanically mixed and mechanically conveyed to the points where it is required, a chuting system being used. The carpenters and men in subsidiary trades are being thrown out of work, mainly through the substitution of steel frames for wooden window frames, and all the steel frames are imported. Steel is being used instead of wood in a number of directions, and joiners are among those who find themselves losing employment as a result. It may be added that the once-flourishing wagon and cart-making industry, carried on in a very big way in Paarl, Grahamstown, and other centres of the Cape Province, has been practically wiped out by the motor car, motor lorry and tractor, all of which are imported.

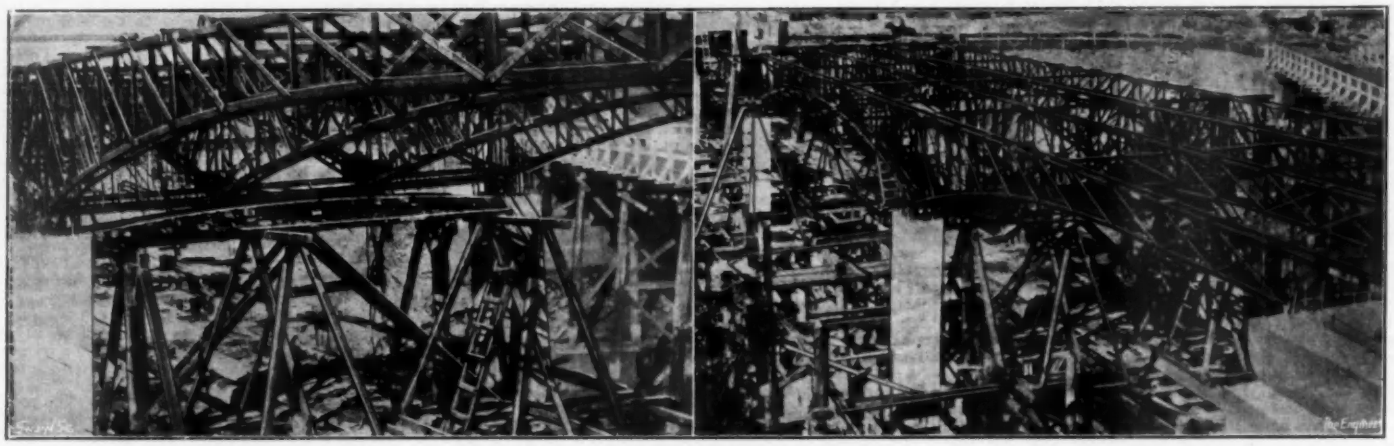
Defective German Engines.

In his report on the statement of accounts of the South African Railways and Harbours, the Controller and Auditor-General for the Union of South Africa devotes considerable space to the subject of defective German engines. He refers in his report to ten articulated "U" type and two "G H" engines. The ten "U" type engines, the capital cost of which was £121,413, were out of service 801 days in 1928—the year they were placed in service—and 1323 days in 1928–29. The committee of investigation found that the axle loads of these engines were over weight, and that the number of lines on which it would be possible to employ the engines would depend on the adjustments of weight which might be found possible by the mechanical department. The Auditor-General asked the General Manager of Railways a number of questions, and learned that the engines were of unsuitable design, which resulted in their being unable to deal with full loads at proper speeds. Unsuitability of design also resulted in a large number of hot axle-boxes, failure of steam and exhaust pipes and other difficulties. The engines were stated to have been built to the designs of the makers. The Administration stated that the defects had been remedied, but from a traffic point of view it could not be said that the engines were satisfactory, or ever likely to prove so. Two "G H" engines, which cost £29,051, were out of service between April, 1928, and March, 1929, for 286 days and 267 days respectively. They were completely out of service from August, 1928, to July and August, 1929. The conclusion come to by the Administration was that the engines could be only used if their weight was reduced, and those alterations were made.

New Liners for South African Trade: British and Foreign Rivalry.

The "Llangibby Castle," a new passenger and cargo ship belonging to the Union-Castle Steamship Company, which also owns the mail steamers running between England and South Africa, recently arrived at South African ports on her maiden voyage. She is a tremendous advance on any of the steamers at present running between England and South Africa, *viâ* the Suez Canal. The "Llangibby Castle" is a twin-screw motorship of 11,951 tons, with spacious accommodation for 250 first-class and 200 third-class passengers. The propelling machinery consists of two sets of supercharged Diesel engines of the Harland-B.W. type. Each main engine is direct-coupled to a propeller and is of the eight-cylinder type, having a three-stage air compressor mounted at the forward end and driven off an extension of the crank shaft to supply the necessary air for fuel injection. The necessary auxiliary power is supplied by three Diesel generating sets, each engine having six cylinders. The auxiliary machinery is electrically driven. The "Llangibby Castle's" horse-power is about 11,000, and she has easily done 17 knots without being pressed. In addition to the "Llangibby Castle," the Union-Castle Company will put on the England–South African route, during this year, 1930, three other motor vessels. One of these, the "Winchester Castle," will strengthen the mail steamer fleet of the company. The "Winchester Castle" was launched on November 19th and is 19,500 tons gross, with accommodation for 750 passengers. The "Warwick Castle," a sister ship to the "Winchester Castle," is under construction, as is the "Dunbar Castle," which is very similar to the "Llangibby Castle," and like that motor vessel is intended for the service between England and South Africa *viâ* the East Coast—all the mail steamers, of course, use the West Coast route. Considerable additions to their fleets on the South African trade have been made by other shipowners, including the Continental and American. The Clan Company placed the new motorships "Clan Macdougall" and "Clan Macdonald" on the South African trade last year. The "Clan Macdougall" is fitted with a derrick with a lifting capacity of over 100 tons. Locomotives weighing 105 tons have already been taken on board and discharged with the ship's gear. The German lines have made special efforts to capture a larger proportion of the passenger and cargo traffic and have, during last year, placed two new steamers in service—the "Watussi" and the "Ubena"—besides reconditioning and completely renovating the "Wangoni" and "Usambara." The American and South African Line are putting a fast motorship of 10,000 tons on the run between New York and South Africa, and two more ships are being built. During the last few months the South African Despatch Line—an American firm—has inaugurated a service from Pacific ports to South Africa with four fast and serviceable motorships. Several new and fast Norwegian ships are making a bid for the South African trade, and the new steamer "Nieuwkerk," just put on by the Holland–Afrika Line, has passenger accommodation of a superior type. Next month the Navigazione Libera Triestina is inaugurating a new service round Africa with four 10,500-ton oil-burning ships, each having accommodation for 60 first-class and 30 third-class passengers. These ships will sail from Italy down the West Coast and return by the East African coast. There will then be eight of the company's vessels operating to and from South Africa. The Elder Dempster Line has extended its South African and East Coast service during the past year and has placed on the Canada–Africa route large and powerful motorships to cope with the increasing trade between those countries. Owing to the increasing popularity of a round-the-world voyage, and the extension of Far Eastern trade, th. Japanese lines are placing in service vessels of a very superior type. One new motor vessel of theirs, the "Buenos Aires Maru," made her first appearance on the South African coast a couple of months back, and her sister ship, the "Rio de Janeiro Maru," is expected to arrive at Cape Town on her maiden voyage during the middle of this year. All classes of marine construction are included in the new tonnage for the South African routes. There are motorships and vessels with turbines, new types of reciprocating engines, which are most economical, and, no doubt, before long, ships will be seen in Union ports adapted to burn pulverised coal. Larger refrigerator space is being provided for the fruit and frozen meat traffic, while the type of passenger accommodation to be found on vessels calling at South African ports is equal to anything to be met with anywhere, with the possible exception of the costly and magnificently appointed great liners on the North Atlantic run. The Natal coal industry will lose 90,000 tons of bunker trade a year when the Union-Castle Company has brought its fleet of motorships up to five at the end of the year. The reduction will also cost the South African railways something like £60,000 a year in lost revenue. This may prove a blessing in disguise by compelling South Africa to concentrate on making better use of its coal resources. Some consider that research work, aiming at the production of oil from coal, should be pursued, but the use of pulverised coal is more widely advocated, as it is considered that the production of oil from coal would involve more capital than the country can afford and the best method has not yet been ascertained.

WELDED REINFORCEMENT FOR A CONCRETE HIGHWAY BRIDGE



Welded Reinforcement for a Concrete Highway Bridge.

THE Western Highway, one of the main interconnecting roads in Victoria, Australia, at one point crosses a reservoir which was constructed some time ago for irrigation purposes. Until recently it was carried across on a timber bridge built at the time when the heaviest loads were horse-drawn traffic. This bridge was of typical construction, with eight spans, each 25½ft. long. Recently, the authorities came to the decision that the amount of water available in the catchment area justified their increasing the storage capacity of the reservoir and resolved to raise the crest of the dam by 10ft. This necessitated either lifting the deck level of the existing bridge, constructing an entirely new bridge, or diverting the roadway.

After consideration, it was decided that a new bridge would be the most satisfactory arrangement and plans for it were prepared. Four types of construction were considered—steel truss, plate girder, single-arch reinforced concrete, and multi-span reinforced concrete. After careful investigation as to the economical and æsthetic advantages of each type, the last method was decided upon. This form of construction would, it was estimated, be less expensive than either of the steel types and approximately of the same cost as a single reinforced concrete span. At the same time, it was considered that it would be more in keeping with the æsthetic requirements of the site.

In order to straighten out a bad "S" bend in the roadway which existed with the old bridge, the line of the new bridge was made at an angle of 60 deg. with the dam. This increased the length of the bridge, including the abutments at either end, to 246ft., in spans of 40ft., 54ft., 56ft., 54ft. and 40ft. The local standard width for highroad bridges—22ft. between kerbs—was adopted, with the addition of a footway 5ft. wide.

Owing to the height of the superstructure above the bed of the reservoir, the cost of erecting an adequate staging to carry the shuttering and newly placed concrete would have been prohibitive. To obviate the need of this staging, therefore, light trusses, which were welded throughout, were constructed to span between the piers. They were made of sufficient strength to carry their own weight and that of the shuttering, wet concrete and light mixing plant. Their form is such that they could be entirely embedded in the concrete and act as a partial reinforcement.

The accompanying engravings show the bridge in a state of semi-completion. The first of them gives some idea of the construction of the welded trusses, while the second gives a more general view of the site, including, on the right, the original wooded bridge. For this work the electric arc was used, together with Quasi-arc electrodes.

American Engineering News.

Balanced Cooling Bed for Rolling Mills.

A NEW type of mechanically-operated cooling bed built recently for handling merchant material is designed to eliminate the tendency to distortion of the material in cooling and also to straighten the material as it travels across the bed. In the centre line of the machine is the runway, or runout, from the rolls, with a longitudinal bar or guide down the middle. As a rolled piece comes from the mill it rides on the line-rollers of the runway, these rollers being set at an angle to the line of the runway so that they hold the piece against the central guide. When the piece reaches the desired position, the skew, or angularity, of the rollers is reversed, so that they throw the piece off the runway on to the table. The next piece comes down on the opposite side of the guide, so that the rollers are then in position to hold it against the guide, until they are again reversed in position so as to throw the piece off on the opposite side of the runway. With this skew, the rollers have an influence in straightening the pieces by holding them against the bed, and it also prevents any tendency of the pieces to fall off the rollers prematurely. Each of the two halves of the bed consists of a series of notched cross pieces, alternate pieces being fixed and movable. The latter are operated by a motor through a pair of excentrics, and a train of pivoted links or bars. One set of excentrics gives a vertical motion to the notched bars and the other set gives a horizontal reciprocating motion, the two motions together being combined to form an elliptical movement of these moving supports. As a bar comes out on one side of the runway these supports move so as to move all bars one notch farther out, leaving an empty notch for the hot bar. The two sides of the cooling bed are counterbalanced, so that power is required only to lift one side at a time.

Ball Mills for Grinding.

From laboratory experiments and a study of the theory and mechanics of ball mills it has been claimed that the speeds determined from previous studies are excessively high. Slippage varies evidently with the amount of the charge. When the charge is more than 35 per cent. of the cubic volume of the mill the slippage is negligible. When the charge is as much as 40 per cent. of the mill volume and the speed is less than 75 per cent. of the critical speed, the charge forms a toe, which prevents the balls from striking the lining of the mill. Maximum grinding effect was obtained with a speed 65 per cent. of the critical speed, while a 50 per cent. speed was the most effective in the use of power. The diameter of the balls is a factor in the speed efficiency, a lower speed being required for small balls than for large balls. In grinding, however, the major part of the work is done by attrition and only a relatively small part by impact. Larger cylinders have been found in actual service to have greater grinding efficiency than smaller cylinders. In one case, 9ft. mills gave 25 per cent. higher efficiency than similar mills 8ft. in diameter, while in other cases 10ft. mills have given 15 to 20 per cent. greater efficiency than 9ft. and 8ft. mills. A side issue is the value of equipping ball mills with roller bearings such as are now widely advocated and used for various kinds of machinery. Experience seems to indicate very little saving in power resulting from such bearings. They give a lower starting torque and are beneficial in accelerating speed, but on the whole their practical value on machines of this kind seem to be doubted by mill operators.

Fertiliser from Sewage Sludge.

In sewage treatment by anaerobic digestion, or by oxidation, with air forced into it, there is a large quantity of resultant sludge which contains appreciable quantities of nitrogen—which is its principal value as a fertiliser—and also some phosphorus and potash. The percentage of nitrogen ranges from about 1 to 4 per cent. at different plants, but as a rule the sludge is either buried or used for filling low ground and is more or less of an encumbrance in the operation of the plants. In several cases, however, it is sold to local farmers at a nominal cost. Among the numerous large and small sewage treatment works in this country, only one produces a material that is sold as fertiliser on a commercial basis. It is the activated sludge plant of the city of Milwaukee, which handles nearly 95,000,000 gallons of sewage daily, with peak loads as high as 140,000,000 gallons. During 1928, the fertiliser output was 33,000 tons, which was sold for about £120,000. Most of it was sold to fertiliser manufacturers, who blend it with phosphates and potash and sell it mainly for use on cotton and tobacco growing lands. The remainder is used in its original state on lawns, parks and golf courses. It is a fine powder, the sludge being passed through dryers and then through pulverisers and screens. Its price is about 6s. 3d. per sack of 100 lb. Its analysis shows 5·42 per cent. total nitrogen; organic nitrogen soluble in water, 0·30; nitrogen insoluble in permanganate, 0·71 per cent.; active nitrogen by alkaline permanganate, 3·22 per cent.; total phosphoric acid, 3·08 per cent.; available phosphoric acid, 2·43 per cent.

Spherical Tanks for Oil and Gas.

For the transportation of helium gas for the airships of the United States Navy an experiment is being made with spherical tanks or containers which are said to weigh 25 per cent. less than cylindrical containers of the same capacity. A special steel-frame railway car holds six of these spheres, which are about 6ft. in internal diameter and 1¼in. thick, to carry gas at 2000 lb. pressure. Each tank is composed of two plates of hemispherical shape welded together. The weight empty is about 8300 lb. The steel used has an ultimate strength of 60,250 lb. per square inch, with an elongation of 22 per cent. in 8in. For a series of severe tests one of the spheres was heated to 1200 deg. Fah. in a furnace and kept at that temperature for four hours. A hydrostatic test was next made and while under 1250 lb. internal pressure it was revolved slowly on a turntable while four pneumatic hammers kept up a succession of sharp blows on a circumferential belt a foot wide. This was continued for three days. The same sphere was then loaded on a car, between two steel cylinders, and the car was run off the end of a trestle 20ft. high to simulate a train wreck. Finally it was subjected to a bursting test and failed at 4466 lb. per square inch, breaking into nine pieces, some of which were thrown as far as 53ft. No failure occurred in the welded joint. The stress at time of fracture was estimated at 57,000 lb. Spherical tanks for ordinary commercial pressures are used for the storage of oil, petrol and gas. A more recent development is a spheroidal tank—or a sphere with flattened bottom—to provide for the combination of gas pressure and liquid pressure which is encountered in the storage of petrol and oil. The largest of these spheroid tanks are 53ft. in greatest diameter and 39ft. high, with capacity of 420,000 gallons, and designed for a gas pressure of 15 lb. per square inch.

Overflow Dam with Stilling Pool.

For a hydro-electric station of the Aluminum Company on the Tennessee River there is an arched concrete dam designed for overflow, and in order to protect its toe and foundation from damage by the falling water a stilling pool or cushion pool is formed by a low concrete dam a little further downstream. At this point the river makes a horseshoe bend and a pressure tunnel, lined with concrete, extends across from the dam to a power station on the opposite side of the bend. The Calderwood Dam is 200ft. high above foundation and has a radius of 312ft. on the downstream side of the crest. There is a constant radius and uniform thickness of 25ft. for 45ft. from the top; below this the radius decreases and the thickness at crown steadily increases. Piers on the crest support a bridge. Deflectors and an apron of reinforced concrete at the base divert the water to the pool, which will be about 65ft. deep at flood time or 35ft. normally. This is formed by a 35ft. gravity dam of ogee section with overhanging crest on the upstream side. The pressure tunnel, 13½ft. in diameter, is 2400ft. long, and at its lower end divides into three branches, in which the 16ft. steel penstock pipes are placed. A surge shaft 18ft. in diameter, with a large chamber at the top, is excavated in the solid rock, the shaft being at an angle of 45 deg. with the centre line of the tunnel. The water surges up the shaft and up a concrete pipe in the chamber, from which it spills into the chamber, the water in which flows back to the shaft through small ports. Three vertical shaft turbines of 56,000 H.P. carry the generators, the turbines running under a head of 213ft.

Chlorinating Condenser Water.

The cleaning of condensers is usually a troublesome task that interferes more or less with the regular operation of the power plant or station. In order to reduce the trouble and cost of this operation and at the same time to improve the efficiency of the condenser, the treatment of the circulation water with chlorine has been tried successfully at the Kearny station of the Public Service Electric Company. Owing to slime accumulations from the river water it had been necessary to clean the condensers frequently to maintain the heat transfer condition. The water is low in oxygen, is badly polluted, and, being near the sea, its salt content is about half that of sea water. There are five condensers, each with 50,000 square feet of surface in 1in. tubes 19ft. long, and each is served by two single-speed circulating pumps with a capacity of 45,000 gallons per minute. Samples of the water were studied and analysed to determine the proper dosage which would kill the slime-forming algæ or growths. The dosage is applied intermittently at regular controlled intervals. Three chlorinators, each capable of handling 720 lb. of chlorine daily, are provided, together with a battery of 150-lb. chlorine tanks or 1-ton containers. A clock regulates the operation automatically by tripping a relay which operates a valve in the pipe supplying water to the injectors on the chlorinators. The discharge of chlorine solution is conveyed through hose pipes to the intake conduit. The clockwork can be adjusted to provide any desired frequency and duration of the dosage. The results have been highly satisfactory in keeping the condensers clean and thus maintaining their heat transfer efficiency without the trouble and cost of frequent cleaning. Chlorine has been used also to clean dirty condensers and continuous instead of intermittent action has also been tried. There has been no corrosion of valves or piping.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Conditions Unchanged.

THERE has been no improvement in the industrial situation in the Midlands and Staffordshire during the week. Activity is of a restricted character, and business is uneven and irregular. The iron and steel market continues quiet, with prices unaltered. Unemployment in this area increases, and engineers, manufacturers, and consumers of iron and steel generally have little incentive to lay in fresh stocks of material. In many cases they are working short time or have depleted staffs. Mechanical and electrical engineers provide what exception there is to this rule.

Raw Iron.

Blast-furnacemen in Derbyshire, Northamptonshire and other centres in the Midlands experience difficulty in securing specifications, but although they have misgivings as to the future they are firmly placed on current account. In this respect they are much better off than their fellows in other parts of the country; moreover, they are getting rid of the greater part, if not the whole, of their present output, whereas reports from other iron-making centres are of a surplus of supplies. Consumers of pig iron in this district, like those elsewhere, are restricting their purchases to immediate requirements and cannot be induced to buy forward. Were it not for the strong position built up over many months by Midland smelters, there would be a different tale to tell. Though it is generally agreed that the foundries are utilising less material now than they were, it is considered that this is only part of the explanation of the restricted character of business in this department of the Midland market. Users of pig iron, it is said, are out for a lower level of prices. Whether they will be able to enforce them or not is at the time of writing undecided. The executive of the Central Pig Iron Producers' Association holds its meeting this week, when the question of minimum selling rates will come up for consideration. The general opinion on 'Change in Birmingham this week is that current prices are likely to be reaffirmed. There are those, however, who contend that smelters will be well advised to make some reduction. Blast-furnacemen in this area, with individual exceptions, are disposing of the whole of their productions, and No. 3 foundry iron, which is the dominant grade in the market, is not in over supply. It is reported, however, that the call for this class of iron in some other districts where Midland iron has been in demand has fallen off considerably of late, and this, together with the undoubted decline in activity at the local foundries, is causing blast-furnacemen some concern. They are all right for the present, but they would like to see an improvement in the outlook for the near future. A number of those who have no pipe foundries behind them express real anxiety and no doubt some of them would be prepared, with the Association's consent, to accept slightly lower prices for their iron. The cheaper coke now available would be of assistance to them in this direction. Buying of pig iron this week has been negligible, for users are awaiting the decision of the Producers' Association before placing even small orders.

Finished Iron.

Conditions remain very uneven in the Staffordshire finished iron trade, and it is impossible to keep all the plant in operation. The bright feature of the market is the larger consumption of best iron by the railway companies, in pursuance of reconditioning work and extensions which they have in hand. A regular output is being made in this department, but it is not up to capacity. In the Crown and common bar branches dull conditions rule. Orders come in irregularly for odd lots. Frequent roll changing is necessary and output programmes cannot be arranged on a scale which make for economy in production costs. Considerable readjustment of labour is necessary to comply with a variety of small orders and specifications. Competition for Crown bars from other districts is maintained, while there is no abatement in the severe competition of continental makers in the nut and bolt bar branch. Finished iron prices are unchanged. Marked bars are quoted £12 10s. per ton, Crown quality £10 to £10 10s., nut and bolt and fencing bars £9 2s. 6d. upwards, iron strip £11 2s. 6d. Makers of the latter are still moderately well employed, but new business is not coming forward as freely as makers desire. It is reported that no great bulk of material is being purchased from Belgium at date, and that Black Country works are not being well employed.

Steel.

There has been no change in the trading conditions in the steel industry during the past week. In the heavy section business is decidedly slow, both as regards specifications and new orders. Local steel masters are pleased to learn that the experiments made by the railway companies with steel sleepers are proving successful. Supplementary orders for steel sleepers are being received from practically all the big railway companies, and the fact that earlier experiments are being followed up by exhaustive tests provides grounds for hopes of substantial business in this line in the future. Constructional engineers are not at date able to use any increased volume of material, while in other branches of engineering in this district business can hardly be termed satisfactory. Indecision and anxiety are discernable in most quarters. It is an unpleasant commentary on the state of the engineering industries and iron and steel trade in the South Staffordshire district that unemployment at date is higher than it has been at any time during the past six years. Finished steel prices are as a week ago. In the half-products branch little new business is in circulation. The recent increase in continental prices has hardly affected business at all. Neither home nor foreign steel masters are pleased with current demand. Birmingham importing merchants say that firms in this area are very reluctant to order. The truth is that works are not consuming material quickly enough to need additional supplies.

Galvanised Sheets.

The galvanised sheet market continues very dull, and despite the fact that some makers, in an endeavour to stem the slump in selling values, have advanced their quotations, others have "cut" last week's minimum of £11 10s. per ton for 24 gauge corrugateds. Demand appears to be practically stagnant and there is little, if any, more business being done at the present low rate than was the case when values were considerably higher. Millowners in this district are discussing the possibility of agreement on basis prices, but there is insufficient union to bring about such an action. Many of the mills are now very badly situated for work, and further curtailment of output will be necessary in the course of a week unless some substantial business is received from oversea markets in the interim. Fortunately, this week has witnessed some improvement on home account, but tonnages are small.

Chain and Anchor Industry.

Mr. C. H. Sitch, the general secretary of the South Staffordshire Chainmakers' and Strikers' Association, in his annual report, made some interesting statements. Now that the shipbuilding industry was making progress, he said, there was every indication, if the position was maintained, that there would be during the current year a great increase in the demand for British-made chains. He pointed out that exports were increasing, and that in 1927 exports of chains and anchors amounted to 15,550 tons, of a value of £673,593; in 1928, 15,112 tons were exported, valued at £652,632; while last year the amount exported rose to 17,591 tons, valued at £724,791. These figures, he declared, proved that English chains were still holding their own. Imports, including all kinds of chain and anchor heads, reached a total last year of about 3000 tons, valued at £68,000. Referring to working conditions in the industry, he said that as a result of the introduction of new mixtures into the metals used by chain makers, more physical energy was required than hitherto, and, further, the burden of chain making had been considerably increased, because the fuel used to-day was in many cases not so clean or as good as in the past. These two factors had made considerable inroads into the level of the workers' wages, because the chain trade was almost wholly a piece-rate trade.

Technical Advancement in Metallurgy.

The progress made in recent years in the development of metallurgy, the shortage of scientifically trained men, and the bright prospects before metallurgists of the right type, were prominently referred to at the annual dinner of the Birmingham University Metallurgical Society on Saturday last. Professor Hanson, the chairman, said that the University was maintaining contact with industry in a variety of ways—by research work, by preparing students to take part in the industries, and by sending students to works during their period of training. The national success of the basic industries of this country depended on the efficiency, prosperity, and development of the metallurgical industries. There was no cause for pessimism in regard to the metallurgical industries. The technical advancement in recent years had been colossal, and that advancement was continuing. One of the most striking features of recent development was the extraordinary uses to which metals were being put. Dr. W. Rosenhain, Director of the Metallurgical Department of the National Physical Laboratory, stated that there was a shortage of scientifically trained metallurgists in the country, and it would be many years before the shortage could be made good. One of the causes of the shortage was the greater demand for scientifically trained men for industry, which was now beginning to appreciate the uses of such men more than in the past. After stating that the entry into the Birmingham University was better than that to other metallurgical schools in the country, Dr. Rosenhain said that there was the possibility of developing in Birmingham a really important school of metallurgical research. There were a number of problems which required research and investigation. He could congratulate the department upon the bright prospects in front of it.

Canal Bridge Reconstruction.

The Rowley Regis Urban Council having considered the question of strengthening and reconstructing weak or inadequate canal bridges in its district, has decided to put before the Ministry of Transport a scheme in respect of seventeen such bridges.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Hundred Years of Railways.

ELABORATE arrangements are being made for the centenary celebrations of the Liverpool to Manchester Railway, to be held at Liverpool in September. The Liverpool organisation is making arrangements for the exhibition of models to be housed in St. George's Hall, while the London, Midland and Scottish Railway Company is taking some pains to stage in Wavertree Park, Liverpool, a display of locomotives and rolling stock of the various types used on British railways since the Liverpool–Manchester line came into operation a hundred years ago. It is estimated that about 50,000 people will be accommodated in the arena which the railway company is constructing in the Park. A circular track is to be laid down, and on it all classes of railway stock, from the ancient to the ultra-modern, will be represented. The historical atmosphere will be provided by elaborate pageants showing the evolution of transport by rail and in them railway workers will play an important part. According to present arrangements, the celebrations will open on Saturday, September 13th, and close on the 20th.

Sea and River Defence Schemes.

Ministry of Health sanction for the borrowing of £29,000 for the construction of sea defence works and a promenade has been secured by Fleetwood Town Council. An immediate start is to be made with the scheme, which provides for the building of a lower promenade about two miles long to join up with the existing defence wall on the west side of the town. A joint conference of representatives of Stretford, Ashton-on-Mersey, Sale, Bucklow, Urmston, and Barton Councils, all local authorities situated within a few miles of Manchester, has just been held to consider proposals for the prevention of flooding from the river Mersey, and the repetition of the serious damage which has been caused from time to time in the past. The estimated cost ranges from £100,000 to £150,000, according to the extent of the works which will be carried out. It is understood that an early conference will take place between the local authorities concerned and the county authorities of Lancashire and Cheshire, the affected districts being in one or other of the two counties.

An Anglo-American Working Arrangement.

It has been reported here during the past week that an arrangement has been entered into between John Summers and Sons, Ltd., galvanised sheet manufacturers, of Shotton, near Chester, and the American Rolling Mill Company, of Middletown, Ohio, under which Summers will manufacture in this country high-grade steel sheets such as, hitherto, have been exported here and to the British Colonies from the United States. Modern plant will be started up at the Shotton works early in March.

New Switchgear for Bury.

The Bury Electrical Engineer has suggested to the Electrical Committee that new high-tension switchgear plant should be installed at the central power station, at a cost, including the necessary buildings, of £27,000. The Committee has decided to ask the Finance Committee to raise the required sum and to recommend the General Purposes Committee to approve the scheme. The Electricity Commissioners have sanctioned the borrowing of £6660 for the purpose of other electrical plant.

Orders for Motor Omnibuses.

Manchester Transport Committee on Tuesday of this week decided to accept the tenders of the Vulcan Motor and Engineering Company, Southport, for fifteen double-deck motor omnibus chassis and bodies, and of Crossley Motors, Ltd., Manchester, and Leyland Motors, Ltd., Leyland, near Preston, for fifteen single-deck omnibus chassis each.

Non-ferrous Metals.

All sections of the non-ferrous metals market have displayed marked weakness since last report, and a good deal of uncertainty as to future movements is in evidence. Tin values seem to be unable to withstand the influence of the continued growth of stocks of the metal in British warehouses, and with plentiful supplies on offer there has been a decline in prices on balance for the week of roughly £3 10s. a ton. The fall was the more severe during the early market sessions of the present week. A further drop has to be recorded in respect of copper, and at the moment of writing the premium on cash metal compared with forward positions is only a question of about 10s. a ton compared with nearly £5 a fortnight ago. As they have been for some time now, buyers are disposed to adopt a very cautious policy. Since about the beginning of the year lead quotations have been more or less stabilised, and a good many people were disposed to regard a continuance of that position as probable. Unexpected weakness developed during the past week, however, and at the moment there has been a loss of about £1 5s. a ton. New low records have been touched by spelter, supplies of which are still much in excess of the demand.

Iron and Steel.

Dull conditions still obtain in iron and steel. There has been no awakening of buying interest among local consumers and contract deliveries to Lancashire foundries appear to be of rather lower aggregate tonnage than of late. There has been no change in the price position, however, Derbyshire and Staffordshire brands of No. 3 being quoted at 77s. per ton delivered equal to Manchester, and Scottish at about 95s. and West Coast hematite at 92s. Orders for finished iron on this market are for relatively limited qualities, though values keep up at £10 15s. for Lancashire Crown quality bars and £9 15s. for seconds. At the moment there are few bright spots in the steel market here. Shortage of work is the more or less general complaint of constructional engineering concerns, and there is corresponding complaint on the part of steel rollers regarding the rate at which contract deliveries are being made. Boilermakers' needs are very soon satisfied, although a moderately steady business in plates is being done with locomotive builders. The demand for most descriptions of bars during the past week has been of limited dimensions. General plates are quoted here at £8 17s. 6d. per ton, boiler plates at about £10, sections at £8 7s. 6d., joists at £8 10s., large bars at £9 7s. 6d., and small re-rolled bars at £8 5s. to £8 7s. 6d.

BARROW-IN-FURNESS.

Hematite.

There is no change of importance in the hematite pig iron trade in this district. There is in some quarters an inclination to anticipate trouble from the coal legislation. There are some stocks at certain works, but they largely consist of parcels of iron which have not been taken up by customers, and, in most cases, it is just a question of awaiting orders for despatch. American business continues and a feature of the market at present

is the steady continental trade. The exports are very regular and likely to continue so. The ore trade is about the same. There have been some heavy deliveries during last week of foreign ore at Barrow, two ships arriving from Almeria, one from Oxelsund and one from Kirkenes. The steel trade is moderate, but Workington and Barrow both have orders for railway material which will keep them engaged for a while. Fresh orders would be welcome for all that.

Shipbuilding.

The Chilian submarine depôt ship "Araucano" left Vickers-Armstrongs' Barrow yard last Saturday for the Clyde, where she will run her trials. She is 390ft. long, 55ft. beam, has a depth of 30ft. 3in., a displacement of 4000 tons and a shaft horse-power of 2500. Her machinery consists of geared turbines. The British destroyer "Arrow," built at Barrow, is just back from her trials. She is of 1300 tons and has a horse-power of 34,000.

SHEFFIELD.

(From our own Correspondent.)

No Revival in Sight.

IT is no pleasant task to have to continue, week after week, writing reports on the disappointing state of the steel trade of this district, but it is, unfortunately, unavoidable. This year has compared unfavourably with last—although that was not by any means a satisfactory one—and it shows no sign of improvement yet. Here and there one may find a firm which is well and profitably employed, but some of the largest steel makers are of opinion that business of a general character continues to fall off. This decline is seen on foreign account as well as home; in fact, the weakest spot in the situation is trade with overseas markets. Users of iron and steel materials appear to have no confidence, and they are buying sparingly and for immediate use only. As a result prices are adversely affected, and quotations are being shaded in several instances. Soft basic billets are 5s. per ton cheaper than was the case a month ago, and a high carbon acid billet having a local sale has fallen by 15s. There is but a small demand for steel scrap, and prices have eased by another half-crown. The market for foundry pig iron is stagnant, and consumers are expecting some concession. The requirements of the textile industries, which normally take a considerable amount of steel for machine building, have probably never been smaller than they are at present. The position in Lincolnshire is better. Although one blast-furnace in that area has been damped down, the steel plants continue to run practically full time, and, while inquiries have recently shrunk a little, they are still booking a considerable amount of new business.

Special Lines.

There are a number of branches of Sheffield trade which are still enjoying a considerable amount of activity. These are the branches which devote themselves to the special requirements of various trades. Some of these, however, are not doing as well as they normally do. A decline is to be noted in the demands made by the automobile manufacturers. While they are sending a substantial amount of business to the city, they are not able, in view of the uncertainty with regard to the future of the McKenna duties, to prepare their spring programmes on the usual comprehensive lines, and their demands upon Sheffield are, consequently, restricted. Firms supplying material to the electrical and general engineering industries have a good deal of work on hand, and the same is true of producers of stainless, heat-resisting and non-corrodible steels, cold-wrought steel and strip. Even the latter, however, are not so well employed as they were a year ago. Mr. Percy Lee, an ex-Master Cutler, whose firm is largely connected with the production of cold wrought steel, wire and strip, states that they have plans for extensions, but these have been postponed until the question of the duties is settled. If handicaps are placed on them they will develop overseas, where encouragement is given to manufacturers, instead of this country. The production of steel balls for use in machines employed in the crushing of minerals is an active line. Several of the Sheffield forges continue to receive orders for these balls, and some have recently been produced which weigh more than 4 cwt. each.

Works Extensions.

It is a relief to turn from the gloomy to the brighter side of the picture, and to learn that some firms are still carrying out extensions of their premises and productive capacity. One of these is Andrews Toledo, Ltd., of the Toledo Steel Works, Sheffield, which, in August last year acquired the well-known business of Jno. Hy. Andrew, Ltd. A large amount of reconstruction work has been put in hand, and arrangements made for extensions in nearly every department. A new Siemens open-hearth furnace and two new re-heating furnaces have been erected and put in operation. Ground has been cleared and tenders invited for the erection of two new rolling mills, and the light forging plant is being extended by two additional steam hammers. There have also been extensive additions to the main warehouse, which is being converted into a modern steel building and many old buildings have been demolished preparatory to their reconstruction on an up-to-date lay-out scheme.

Railway Work.

There is nothing very cheering to report about the state of the departments producing railway axles, tires, and springs. The large plants, which have a great capacity for accepting work and rapidly executing it, are not employed to anything like their full extent. Orders placed by the home railway companies are still on a meagre scale, and but little work has been received from the export markets during the present year. The Crown Agents for the Colonies have just given an order for underframes to Cravens Railway Carriage and Wagon Company, Ltd., Sheffield, and one for tires to John Baker and Bessemer, Ltd., Rotherham. The trade is interested just now in some Indian requirements. The India Store Department has invited tenders for 44 locomotive boilers; 1112 pairs of wheels and axles, 5ft. 6in. gauge; 2122 pairs of wheels and axles, metre gauge, and 644 metre-gauge wheels, with tires only. The Bengal and North-Western Railway Company is in the market for two boilers, and duplicate parts for locomotives.

Some Government Orders.

The Admiralty has just placed a large and important order for micrometers with Ambrose Shardlow and Co., Ltd., of Sheffield. The manufacture of these instruments was, until recent times, largely in foreign hands, but Messrs. Shardlow have undertaken their production with a considerable measure of success, and have made good progress in securing orders in the face of foreign competition. The Admiralty has also ordered steel blooms from the English Steel Corporation, Ltd., and W. Jessop and Son, Ltd.; cooking apparatus from Moorwoods, Ltd., and mooring shackles and pendants from Thos. Firth and Sons, Ltd., all Sheffield firms. Recent War Office orders include:—Bullet-proof plates from Hadfields, Ltd., Sheffield, and steel billets from the English Steel Corporation, Ltd., Sheffield. The Crown Agents for the Colonies have placed a contract for pipes with the Staveley Coal and Iron Company, Ltd., and one for motor cycles with Dunford and Elliott, Sheffield.

Mining Matters.

Silverwood colliery, near Rotherham, which has on several occasions accomplished fine production performances, has just beaten its own record. In the week ending February 19th it brought to the surface no less than 30,924 tons of coal. Its previous best was 30,427 tons in the week ended January 15th. Included in the latest figures are 24,605 tons drawn up the West Pit shaft in eleven shifts, which is thought to be a record. The Midland Institute of Mining Engineers is very much interested just now in the question of the underground loading and conveyance of coal by mechanical means. Not only has it devoted much attention to the question as a whole—a joint committee of the Institute and the South and West Yorkshire Coalowners having drawn up a comprehensive and valuable report—but it has had before it the use of the scraper loader, a device which is known in America but which is still to a large extent a novelty in this country. The first successful applications of this method in British mining have, in fact, been local. An installation was put down at the Grange Colliery of Newton, Chambers and Co., Ltd., near Sheffield, in March last year, and was followed soon after by one at the Nunnery Colliery, Sheffield. Both these installations were described by men prominently associated with their working at a meeting of the Institute last week. While it is not claimed that the scraper loader will do away with the ordinary conveyor in all conditions, and while it is also admitted that much further experimental work is required, it is contended that under suitable conditions scraper loading should prove an efficient method of working, giving a maximum of simplicity together with great flexibility in application. One of the advantages claimed for it is that it greatly lightens the labour of the men engaged in filling the coal, as in the main the coal has only to be pushed and does not require to be lifted. Again, no heavy work is required to flit the comparatively light tackle used, although more intelligence is necessary. As compared with flitting a pan conveyor, the cost is considerably less.

Cutlery and Plate.

In the cutlery and plate trades conditions continue quiet. A revival of buying is usually experienced about the end of January, but it has not yet come about and travellers have no favourable reports to send in, as retailers are ordering new stock very cautiously. The sixpenny bazaars, whose demands were largely responsible for an exceptionally busy Christmas season, are now taking reduced quantities. Compared with last year, the overseas demand for cutlery is sluggish. A quiet period seems to be overtaking the trade in safety razors and blades, the production of which is not up to last year's average. The falling off is largely on overseas account. Some firms engaged in the trade are having difficulty in finding outlets for their product. The trade in scissors and best pocket cutlery keeps up well, and there is much less foreign competition in this department than there was a year ago, but energetic efforts are being made to push German goods in foreign and Colonial markets. The War Office has given contracts for forks and spoons to Mappin and Webb, Ltd., and for table knives to Sheffield Steel Products, Ltd.

Greek Contract Extended.

The great contract for irrigation and land reclamation work in Greece, placed with Henry Boot and Sons, Ltd., the Sheffield contractors, is now only awaiting final ratification by the Greek Senate. This is expected at any time, and when it is received Messrs. Boot will send out two fully equipped parties to commence the engineering surveys, who will be followed at an early date by further units. In the meantime the contract, already estimated to involve an expenditure of at least £6,000,000, has been extended. To the works in Thessaly, Crete, and Epirus, originally included, the Greek Government has added further works in Kephisus, which will increase the cost by more than £500,000.

Hull Schemes.

Hull Corporation has now come to a satisfactory arrangement with the London and North-Eastern Railway regarding the acquisition of the Queen's Dock, and has decided to purchase it for £117,000. The dock will be filled in during the next three years, and will provide Hull with an open space of 22 acres in the very heart of the city. The vote at a recent poll of Hull ratepayers having been against the running of trolley buses, the Corporation has decided to purchase twelve petrol buses to replace the other type of vehicle. Tenders have been accepted at a price of £1265 each for the chassis, £807 each for six of the bodies, and £789 each for the other six.

NORTH OF ENGLAND.

(From our own Correspondent.)

Engineering Works Closing Down.

OWING to the depression in the heavy engineering industry, the directors of Richardsons, Westgarth and Co., Ltd., have decided to close down their Middlesbrough branch works for the present. About 500 employees, who have been working intermittently during the past few years, are under notice. It is the intention of the firm to concentrate on its Hartlepool and Sunderland engineering shops for the present. The Middlesbrough branch works extend over a wide area, and form the largest engineering plant in the Tees-side district. All kinds of steam and Diesel engines, marine boilers, and various classes of general heavy engineering work have been turned out by this department, which is fitted with up-to-date machinery. The castings for the purpose were obtained from the head works at Hartlepool. Attached to the works is a large wharf, notable for its sheer legs, which are the largest on the river Tees, and are capable of lifting 100 tons. The ownership of the works by Richardsons, Westgarth and Co. dates back to 1895, when they were taken over from Hopkins, Gilkes and Co., an engineering and bridge-building concern now defunct. At that time the firm was known as Sir Christopher Furness, Westgarth and Co., the name becoming, after the amalgamation in 1900, Richardsons, Westgarth and Co.

Cleveland Iron Trade.

There are still no signs of an expansion of business in the Cleveland pig iron trade. Confidence seems to be entirely lacking. Traders are apprehensive, and consumers will only purchase on a strict hand-to-mouth basis. Producers have still a good deal of work to execute, but it is felt that unless an early revival takes place output will have to be curtailed. Despite the general stagnation, however, sellers decline to cut prices, taking the view that concessions would not stimulate the sluggish demand. Thus No. 1 Cleveland foundry iron remains at 75s.; No. 3 G.M.B. at 72s. 6d.; No. 4 foundry at 71s. 6d.; and No. 4 forge, 71s.

Hematite Pig Iron.

Both makers and merchants are keenly seeking orders for East Coast hematite pig iron. The latter have still command of substantial quantities, and are anxious to unload their holdings. Producers are stocking quite a lot of their output, but state that much of it is sold. Continental competition for orders abroad is keeping the products of this area out of several overseas markets that have hitherto drawn considerable supplies from this district. Sellers offer mixed numbers freely on the unremunerative basis of 78s. No. 1 quality is at a premium of 6d. per ton.

Ironmaking Materials.

Little or no effort is being made to put through business in the foreign ore trade. Nominally best Rubio remains at 22s. 6d. c.i.f. Tees. Blast-furnace coke of good average quality is on sale at 21s. delivered at the works, and supply is plentiful.

Manufactured Iron and Steel.

Prices of manufactured iron and steel are not quotably altered, but values of some descriptions of material are easy. In all branches forward orders would be welcome, and in one or two departments new work for early delivery is needed. Sheet makers are still far from well placed as regards contracts. Producers of shipbuilding material, bridge building requisites, and necessities for railway construction have order books that promise to keep them busy for some time, but complain of the extent of distribution of specifications.

The Coal Trade.

The general trend of the Northern coal market shows no improvement, but operators hope that some of the large inquiries circulating will soon materialise into definite business, and are sustained in that belief by the low level of coal prices, combined with cheap freights, which enable them to offer c.i.f. terms that ought to be more tempting to consumers abroad. The main check to expansion of business continues to be the overstocked position at most of the continental centres, owing to the long period of mild weather. In the early part of last year the lower prices then prevailing attracted a large amount of trade to the Northern coal market. Subsequently values got to a level that checked further business, and lately a dull spell has set in. In the course of February some grades of coal have fallen away about a shilling a ton, but more steadiness is now apparent. In fact, the lessened prices lately indicated for certain qualities have brought in a little more trade, but not nearly sufficient to impart firmness to the March position. The prompt position for Northumberland best steams is steady at 15s. 6d. to 15s. 9d. These prices are asked for all March delivery, but buyers are holding off. Steam smalls are the best feature of the market, being well sold ahead at good prices. They are still in brisk inquiry. Fresh trade is moving slowly for the Durham collieries. Supplies are excessive and there is an easing tendency in most prices. Durham steams are fairly well booked, large sorts being 17s. to 18s., and smalls 14s. to 14s. 6d. Gas coals are moving off well for the best qualities at 16s. 6d. to 17s., and seconds at 14s. to 14s. 6d. There is a surplus of coking coal, which is a weak market, 14s. to 14s. 3d. being quoted for smalls and 14s. 6d. to 14s. 9d. for better grades. Bunkering fuel is in lessened demand and in ample supply, bests and superiors at 16s.

to 16s. 9d., and ordinary sorts at 14s. to 14s. 6d. The coke trade is not showing signs of any immediate recovery, and the few transactions passing are limited to small parcels. Gas coke is offered in moderate volume at 22s. Patent oven coke stocks are excessive and demand slow. Sellers offer freely at 19s. to 21s. Beehive and special grade foundry cokes are steady at 26s. to 30s.

SCOTLAND.

(From our own Correspondent.)

Featureless Markets.

So far as the steel, iron and coal markets are concerned, the past week has produced nothing in the way of fresh features and business, more or less, continues on recent lines. Though of late there have been signs of improvement in certain directions, chiefly in the nature of better prospects in the shipbuilding industry, and in some departments of engineering in Lanarkshire, the general outlook is still unsatisfactory owing in a measure to heavy on-costs and to keen competition from abroad.

Steel.

Makers of heavy steel are maintaining a steady rate of output at the moment, but other branches of the industry are quiet and employment is uneven. With regard to steel sheets reports are rather mixed. Light black sheets are comparatively well specified, but other descriptions are more or less neglected and the total tonnage is not sufficient to keep the works regularly employed. It has been explained that the quietness in the sheet industry is largely due to a slump in galvanised descriptions, prices of which are at a very low level at present, especially for export; in fact, the prices obtainable for shipment represent a substantial loss. So far as tubes are concerned, makers have not yet experienced much benefit from the renewal of the Cartel arrangements, and in the export department, especially, there is ample room for expansion.

Iron.

The iron market on the whole shows no change. The depression in the bar iron industry is as keen as ever, and the demand for re-rolled steel bars is far from satisfactory. The home price of bar iron is unchanged at £10 5s. and export remains in the neighbourhood of £9 15s. per ton. The home and export quotation for re-rolled steel is round about £7 12s. 6d. per ton. Business in pig iron is of a very restricted character, the demand being affected by substantial arrivals of basic iron from India and offerings of continental iron; minimum prices are as follows:—Hematite, 81s., No. 1 foundry, 80s. 6d., and No. 3 foundry, 78s., all per ton for home delivery.

Scrap.

The turnover in scrap has diminished during the past week or two, and supplies are now plentiful. Prices are easier, with heavy steel at 65s., heavy basic 62s. 6d., and cast iron machinery about 69s. per ton.

Coal.

The export branch of the coal trade is most inactive. Prompt demands are few and for small quantities, while forward transactions are hardly entertained. Those districts relying on shipping orders are, therefore, poorly occupied at present, and that is especially noticeable in the Fifeshire district, where third-class steams in particular are poorly placed and washed nuts little, if any, better off. A better home demand has steadied the market for Lothian steams, and double nuts in the same district are improving. Lanarkshire best splints maintain a firm attitude, but other descriptions, including nuts, are in need of orders. Many collieries have still a fair quantity of export orders to overtake, but the difficulty of doing fresh business is accentuated by the uncertainty created by the Government's Coal Bill and the colliery schemes, the ultimate effect of which cannot be gauged, and also by the disinclination of importers in continental and Scandinavian countries to enter into fresh contracts, holding, as it is reported they do, heavy stocks at present. Export prices, therefore, are not being properly tested. Aggregate shipments amounted to 239,029 tons, against 264,976 tons in the preceding week, and 226,199 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE position in the steam coal industry at the present time is far from satisfactory, and the outlook is by no means bright. Collieries are working irregularly, though perhaps that statement does not apply so much to those in the Monmouthshire area, and those at which the supplies being taken by the Italian State Railways are produced. New orders on the market are slow to come along, though now that the outward freight market displays signs of improvement a few consumers have arranged for prompt cargoes. The volume of business, however, is very inadequate to the needs of the market generally. As a matter of fact, shipments last week were the lowest for any week this year, and this is not surprising, in view of the fact that at the end of last week there were as many as thirty-seven idle tipping appliances at the various docks, which, in itself, shows that many collieries must have been suffering for the want of a ready outlet for their coals. According to the Great Western Railway Company's returns, which, of course, embrace Swansea and Port Talbot, and include shipments of anthracite as well as steam coals, the total of shipments at the docks under the company's control was 588,000 tons, which compares with 613,600 tons for the preceding week. Arrivals of tonnage over the week-end somewhat improved the position at the docks, but it was not a great amelioration, as on Monday there were still thirteen idle tipping appliances and only one steamer was waiting to load. It is difficult to see where any material improvement is to come from for a time, as the foreign inquiry for coals is comparatively limited. Two important contracts certainly are pending. One is that for 200,000 tons of steam coals for the Central Railways of Brazil, for delivery over the next three or four months. Prices have gone in, and it is reported that a Cardiff firm has tendered the lowest figure, but it may be some days before the order is definitely placed. The other is for account of the Portuguese State Railways, and the quantity is 100,000 tons of small coals for delivery at Lisbon and Oporto during April, May, and June. It is possible that something will be known at the end of this week regarding the placing of the contract. News is also awaited regarding business for the French Marine, but in this case the quantity is not large.

Ship-repairing and Shipping.

Activity in the repairing yards of this district has fallen off to some extent during the past week or so, which is not altogether surprising, in view of the action of so many shipowners in laying up their steamers on account of rates of freight being so unremunerative. It is well known that round about 200 steamers, with an aggregate carrying capacity of 1½ million tons, are on the laid-up list, and this list is being added to every day. Ship-repairing firms were bound to suffer as the result of so much tonnage being taken out of commission, and, of course, immediately owners have laid up their boats, it is not likely that they will bring them out again unless the market displays such an improvement as will permit owners of running their steamers at least without making a loss. The laying-up process is undoubtedly having its effect upon the market, as the tone all round shows more steadiness, and in some directions it is 3d. to 6d. per ton better than it was a week ago. The only reason that the outward market has not displayed more recovery, even up to now, is that fresh orders for coals have not come along as well as might have been expected. It requires comparatively little expansion in the demand to infuse new life into the outward freight market and cause an advance in rates.

Research Appointment.

Dr. L. B. Pfeil, who is Senior Lecturer on the teaching staff of the Metallurgical Department of the University College of Swansea, has been appointed to the position of senior research metallurgist in charge of the Mond nickel research laboratory, stationed at the Henry Wriggings works of the company in Birmingham. Dr. Pfeil, who is thirty-two years of age, will take up his duties in the near future. He came to Swansea nine years ago as assistant lecturer in metallurgy after graduation at the Imperial College of Science and Technology, London.

Current Business.

The inquiry for coals for prompt loading continues to be on a very meagre scale, and the tone of the market all round is somewhat dull and lifeless. Large coals of all descriptions are on the minimum, but smalls maintain a good tone, for the reason that production of these qualities is so restricted, owing to collieries working irregularly. Coke is also less active in demand, and patent fuel makers are not so well stemmed as was formerly the case. Pitwood is in ample supply; in fact, the demand is not equal to it, and as a result, the market for this commodity is easy at round about 24s. to 24s. 6d.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MERRYWEATHER AND SONS, Ltd., of Greenwich-road, London, S.E. 10, were entrusted with the arrangements for the fire protection of the British Industries Fair.

MR. PAUL H. MANGIN, late general manager of Millars Machinery Company, Ltd., has joined the board of Lewenz and Wilkinson, Ltd., of 25, Victoria-street, Westminster, S.W. 1.

MESSRS. DAVIS AND LLOYD, of 26, Victoria-street, Westminster, S.W. 1, ask us to announce that the Bethlehem Steel Export Corporation, of 25, Broadway, New York City, has appointed them its London agents.

THE SUNDERLAND FORGE AND ENGINEERING COMPANY, Ltd., asks us to announce that it has a new London office at 60, Fenchurch-street, E.C. 3 (adjacent to Fenchurch-street Post Office). Telephone number is Royal 8949 (2 lines), and telegraphic address, "Sundforge, Fen, London."

THE WESTINGHOUSE BRAKE AKD SAXBY SIGNAL COMPANY, Ltd., asks us to announce that the following appointments have been made:—Mr. H. G. Brown, managing director, to be deputy chairman; Capt. B. H. Peter, general manager, to be managing director; Mr. W. H. Powell, general business manager, to be general manager, and Mr. J. Griffith Hall to be secretary in place of Mr. R. Payne, deceased.

THE J. L. EVE CONSTRUCTION COMPANY, Ltd., 272–4, Vauxhall Bridge-road, Victoria, S.W. 1, informs us that it has just been incorporated, mainly for carrying out transmission line contracts. Mr. J. L. Eve was personally in charge of the transmission line department of the Foundation Company, Ltd., and has brought with him the organisation and staff which constituted that department. The new company has had transferred to it from the Foundation Company the following contracts:—Ludlow Craven Arms, Barking–Romford overhead line, river Tay crossing.

CONTRACTS.

S. G. LEACH AND CO., Ltd., of 26–30, Artillery-lane, London, E. 1, received the order for and have just completed the equipment of the Topical Films Laboratories with their Modine unit heater.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., has received from the Birmingham Railway Carriage and Wagon Company, Ltd., an order for 400 "Prestall" vacuum brake sets for wagons which the latter company is building for the Buenos Aires and Pacific Railway.

BRUCE PEEBLES AND CO., Ltd., of Edinburgh, have received an order for a mercury-arc rectifier equipment from the Edinburgh Corporation. The equipment is to comprise a 1500 kW Peebles–Brown Boveri mercury arc rectifier, designed for three-phase, 50 cycles, 6500/6800 volts on the A.C. side, and 550/600 volts on the D.C. side. It is to operate on a traction load.

THE ENGLISH ELECTRIC COMPANY, Ltd., has received the following orders for trolley omnibuses:—(1) From Pontypridd for seven single-deck, saloon type vehicles; (2) from the Southend Corporation for two double-deck, top-covered vehicles; and (3) from Christchurch, New Zealand, for six three-axle chassis and equipments.

BOVING AND CO., Ltd., have just received an order from the Mount Lyell Mining and Railway Company, Ltd., of Tasmania, for a spiral encased turbine to have an output of 2800 B.H.P. on a head of 375ft. at 750 r.p.m. This turbine is for the Yolande River scheme and is specially interesting in that it is to be completely automatic and is equipped with protective devices.

THE CENTRAL ELECTRICITY BOARD has officially announced that it has placed orders to an approximate total value of £230,000 in connection with the Mid-East England electricity scheme with (1) Johnson and Phillips, Ltd., Charlton, S.E., for 33-kilovolt transmission lines; and (2) the English Electric Company, Ltd., Stafford, for 132-kilovolt transformers. The order for transformers is additional to those recently announced.

LAUNCHES AND TRIAL TRIPS.

PRASIANELLA, tank motor vessel; built by Bow, McLachlan and Co., Ltd., to the order of Anglo-Saxon Petroleum Company, Ltd.; dimensions, 180ft. by 34ft. 6in.; to carry 800 tons of fuel in bulk. Engines, two Kromhout oil engines, developing 350 B.H.P. each at 230 r.p.m.

ULSTER QUEEN, motor passenger vessel; built by Harland and Wolff, Ltd., to the order of Ulster Imperial Line (Belfast Steamship Company, Ltd.); dimensions, length 345ft., breadth 46ft., depth 19ft.; gross tonnage, 3760. Engines, two ten-cylinder, airless-injection trunk-type; constructed by the builders; trial trip, February 11th.

DJBEL-DIRA, steamer; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of Compagnie de Navigation Mixte; dimensions, length 336ft., breadth 44ft. 9in. to carry 3500 tons. Engines, double-reduction geared Parsons turbines; launch, February 13th.

BISCA, single-screw motor tank ship; built by Sir W. G. Armstrong, Whitworth and Co. (Shipbuilders), Ltd.; to the order of Per Gjerding; dimensions, length 408ft., breadth 54ft. 9in., depth 32ft.; to carry 8840 tons. Engine, Armstrong-Sulzer, two-stroke, single-acting, six-cylinder, Diesel; launch, February 14th.

HENRI ESTIER, steamer; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of Société Maritime Nationale; dimensions, length 263ft., breadth 38ft. 6in., depth 20ft. 9in. Engines, triple-expansion, 20½in., 33in., 54in., by 36in. stroke; constructed by the builders; launch, February 14th.

LUXOR, oil tank motor ship; built by Palmers Shipbuilding and Iron Company, Ltd.; to the order of H. E. Moss and Co.'s Tankers, Ltd.; to carry, 9500 tons. Engines, Wallsend-Sulzer Diesel; trial trip, February 14th.

EDUCATIONAL INTELLIGENCE.

UNIVERSITY OF LONDON: KING'S COLLEGE, STRAND, W.C. 2: DEPARTMENT OF MECHANICAL ENGINEERING.—A course of three lectures on "Engines for Aircraft" will be delivered on Tuesdays, at 5.30 p.m., by Wing-Commander T. R. Cave-Brown-Cave, C.B.E., R.A.F. March 4th, "Air-cooled Engines"; March 11th, "Water-cooled Engines"; March 18th, "Compression-ignition Engines and Accessories." The above course is free to regular students of the College Faculty of Engineering; for others the fee for the course is 10s. 6d.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS.—A provincial centre of the Institution of Locomotive Engineers has recently been established in Birmingham, for the purpose of fulfilling the functions of the Institution in the Midlands district. Papers are promised from both members and non-members who are prominent in the engineering industry. Non-members are welcomed at the meetings.

THE ROYAL GOLD MEDAL FOR ARCHITECTURE.—The Royal Institute of British Architects announces that intimation has been received that his Majesty the King has approved the award of the Royal Gold Medal to Mr. Percy Scott Worthington, M.A. (Oxon), Litt.D., F.S.A., F.R.I.B.A., in recognition of the merit of his executed work. The Medal will be presented to Mr. Worthington on Monday, March 17th, 1930.

OLD CENTRALIANS.—The twenty-seventh Annual Dinner of the Old Centralians—the Old Students' Association of the City and Guilds (Engineering) College—will be held at the Hotel Cecil on Friday, March 7th, at 7.15 p.m., for 7.30 p.m. Sir Atul C. Chatterjee, K.C.I.E., the High Commissioner for India, will be the guest of the evening. Early application for tickets should be made to the Honorary Secretary of the Association, Mr. W. F. Simonson, 61, St. Mildred's-road, Lee, S.E. 12.

ENGINEERING GOLFING SOCIETY.—The twenty-first annual general meeting of the Engineering Golfing Society was held, by permission of the Institution of Mechanical Engineers, in the Institution building, on Wednesday, February 26th, R. J. M. Inglis, retiring Captain, in the chair. Office bearers for the current year were elected as follows:—President, Sir Robert A. Hadfield; Vice-Presidents, D. A. Stevenson, E. L. Mansergh, F. J. Walker, S. Price-Williams, W. H. Shortt, E. W. Timmis, K. A. Wolfe Barry, W. L. Mansergh; Captain, H. P. Allison; Honorary Secretary and Treasurer, H. C. Siddeley; and Honorary Auditor, S. C. Lewis. The following were elected members of Committee:—B. Hall Blyth, P. Boswell Brown, H. P. Gaze, H. G. Hale, W. W. Hughes, R. J. M. Inglis, C. W. Myddleton, E. S. New, P. L. Riviere.

INSTITUTION OF CIVIL ENGINEERS—ANNUAL DINNER.—The annual dinner of the Institution of Civil Engineers was held in the Institution building, Great George-street, Westminster, on Wednesday evening last, February 26th. Between 250 and 300 members and guests sat down in the Grand Hall, under the chairmanship of the President, Mr. W. W. Grierson. After the usual loyal toasts had been propounded by the President and duly honoured, Sir John A. F. Aspinall, D.Eng., a Past-President, proposed the health of "His Majesty's Ministers," which was responded to, in a characteristic speech, by Mr. Herbert S. Morrison, the Minister of Transport. The Hon. Sir George W. Fuller, Agent-General for New South Wales, then submitted the toast of "The Institution of Civil Engineers," to which the President replied. The toast of "The Guests," which was proposed by Sir Brodie H. Henderson, K.C.M.G., C.B.—a Past-President—was responded to by His Excellency Don José E. Uriburu, the Argentine Ambassador, and the Right Hon. Lord Wargrave, P.C., Prime Warden of the Goldsmiths' Company.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/6 to 21/-
(1) Spanish	21/6 to 23/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 1 0	—
No. 1 Foundry	4 0 6	—
No. 3 Foundry	3 18 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 18 0	3 18 0
No. 1	3 18 6	3 18 6
Cleveland—		
No. 1	3 15 0	3 15 0
Silicious Iron	3 15 0	3 15 0
No. 3 G.M.B.	3 12 6	3 12 6
No. 4 Foundry	3 11 6	3 11 6
No. 4 Forge	3 11 0	3 11 0
Mottled	3 10 6	3 10 6
White	3 10 6	3 10 6
MIDLANDS—		
(3) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 15 6	—
„ „ Foundry	3 19 6	—
(3) Northampton—		
Foundry No. 3	3 15 0	—
Forge	3 11 0	—
(1) Derbyshire—		
No. 3 Foundry	3 18 6	—
Forge	3 14 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 13 6	—
No. 4 Forge	3 9 6	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 9 6 (*a*) / 4 11 6 (*b*) / 4 15 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 15 0	—
Second Quality Bars	9 15 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 2 6 to 9 7 6	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ¼in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	12 5 0	11 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	8 5 0 to 8 7 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	10 0 0	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 10 0	—
Hoops	9 15 0 to 10 5 0	—
Soft Wire Rods	8 0 0	—
MIDLANDS—		
Small Rolled Bars	8 0 0 to 8 15 0	—
Billets and Sheet Bars	6 2 6 to 6 12 6	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	11 10 0 to 11 15 0	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/3 to 18/9
Block Tin (Cash)	170 10 0
„ (three months)	173 10 0
Copper (cash)	69 5 0
„ (three months)	68 15 0
Spanish Lead (cash)	20 3 9
„ „ (three months)	20 0 0
Spelter (cash)	18 15 0
„ (three months)	19 2 6
MANCHESTER—	
Copper, Best Selected Ingots	78 15 0
„ Electrolytic	84 7 6
„ Strong Sheets	110 0 0
„ Tubes (Basis Price), lb.	0 1 3
Brass Tubes (Basis Price), lb.	0 1 1
„ Condenser, lb.	0 1 3
Lead, English	21 17 6
„ Foreign	20 5 0
Spelter	19 0 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/4½ per lb.	
Ferro Tungsten	3/1½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 7 6	7/6
„ „ 6 p.c. to 8 p.c.	£22 10 0	7/-
„ „ 8 p.c. to 10 p.c.	£22 0 0	7/-
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£30 7 6	10/-
„ „ „ 1 p.c. carbon	£38 0 0	15/-
„ „ „ 0·70 p.c. carbon	£41 0 0	15/-
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home; £13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- per unit	
„ „ 75 p.c.	£19 0 0 scale 7/- per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS

SCOTLAND.

(*Prices not stable.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/-
„ „ Ell	16/-
„ „ Splint	16/9 to 18/-
„ „ Trebles	14/-
„ „ Doubles	13/-
„ „ Singles	13/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/-
„ „ Jewel	17/6
„ „ Trebles	14/-
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	12/6 to 14/6
Screened Navigation	18/- to 19/6
Trebles	13/6
Doubles	13/-
Singles	13/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	14/-
Secondary Steam	13/6
Trebles	13/6
Doubles	12/9
Singles	13/-

ENGLAND.

(8) N.W. COAST—	
Steams	21/6 to 23/-
Household	38/- to 51/-
Coke	25/-
NORTHUMBERLAND—	
Best Steams	15/3 to 15/6
Second Steams	14/3 to 14/6
Steam Smalls	11/-
Unscreened	13/-
Household	25/- to 37/-
DURHAM—	
Best Gas	16/6
Second	14/6 to 15/-
Household	25/- to 37/-
Foundry Coke	25/- to 30/-
SHEFFIELD—	Inland.
Best Hand-picked Branch	26/6 to 28/- —
Derbyshire Best Bright House	21/- to 23/- —
Best House Coal	20/6 to 21/6 —
Screened House Coal	18/6 to 20/- —
„ „ Nuts	16/6 to 18/- —
Yorkshire Hards	15/6 to 17/- —
Derbyshire Hards	15/6 to 17/- —
Rough Slacks	9/- to 10/- —
Nutty Slacks	7/6 to 8/6 —
Smalls	3/- to 5/- —
Blast-furnace Coke (Inland)	17/- on rail at ovens
Furnace and Foundry Coke (Export), f.o.b.	20/- to 21/-

(9) SOUTH WALES.

CARDIFF— Steam Coals :	
Best Smokeless Large	20/- to 20/3
Second Smokeless Large	18/9 to 20/-
Best Dry Large	19/- to 19/6
Ordinary Dry Large	18/6 to 18/9
Best Black Vein Large	18/6 to 18/9
Western Valley Large	18/3 to 18/6
Best Eastern Valley Large	18/- to 18/3
Ordinary Eastern Valley Large	17/9 to 18/-
Best Steam Smalls	14/9 to 15/-
Ordinary Smalls	13/6 to 14/6
Washed Nuts	19/6 to 28/-
No. 3 Rhondda Large	21/- to 21/6
„ „ Smalls	15/6 to 16/-
No. 2 „ Large	17/- to 17/3
„ „ Through	16/- to 16/6
„ „ Smalls	15/- to 15/6
Foundry Coke (Export)	32/6 to 37/-
Furnace Coke (Export)	27/- to 28/-
Patent Fuel	22/- to 22/6
Pitwood (ex ship)	24/3 to 24/9
SWANSEA— Anthracite Coals :	
Best Big Vein Large	36/- to 38/-
Seconds	28/6 to 32/-
Red Vein	24/- to 28/-
Machine-made Cobbles	42/6 to 45/-
Nuts	43/- to 46/-
Beans	25/- to 27/6
Peas	20/- to 20/6
Breaker Duff	10/9 to 11/3
Rubbly Culm	12/- to 12/6
Steam Coals :	
Large	20/- to 21/-
Seconds	18/6 to 19/6
Smalls	13/6 to 15/-
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 12/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/- if home consumers confine purchases from associated British Steel Makers.

French Engineering Notes.

(From our Correspondent in Paris.)

The Steel Situation.

FOLLOWING upon the creation of international sales comptoirs which are to remain in operation temporarily pending the formation of the permanent sales organisation to be placed under the direct control of the Steel Cartel, the French sheet makers have at length come to an agreement for the constitution of their syndicate. There have been prolonged negotiations over the distribution of orders, and two large mills still hold aloof, although their owners have agreed to work in harmony with the syndicate. The organisation of the steel trade in the four countries concerned in the Steel Cartel is, therefore, now complete, and it is expected that the meeting of the Cartel to be held in Paris this week will see another important advance in the arrangements for the renewal of that body on a broader basis. It is still hoped that, when that is effected, it will be possible to bring in British steel firms, but it is obvious that nothing can be done in that direction until steel makers in Great Britain are organised in the same way as continental producers. There have been statements to the effect that the Steel Cartel has been in communication with the American steel industry with a view to co-operation.

Trade Restrictions.

It is noteworthy that while the French delegates at Geneva are favourable to the tariff trûce proposal, French manufacturers are hostile to any such arrangement being come to until they have got the maximum measure of protection. They are beginning to view the situation with some uneasiness, for it is clear that they cannot rely upon the home demand indefinitely, and the foreign trade is slipping out of their hands. There is no immediate cause for anxiety, as there is still full employment in the metallurgical and engineering trades, but it is certain that for some time past things have been getting quieter and orders are coming in less freely. When manufacturers see that foreign markets are being closed by higher tariffs, to say nothing of keener competition due to heavier production, they naturally seek to protect their home market, and it is interesting to note that in view of the British movement in favour of Imperial protection there are suggestions in this country that it may be necessary to adopt a similar policy with regard to the French colonies. Such a policy, however, would not favour essentially French products, and there is no doubt that, if the industrial situation should become worse, there will be stronger support for the Geneva proposals, which alone can widen markets for the particular classes of goods that are specialised in this country. So far as steel products are concerned the difficulty has been overcome by the operations of the Cartel and the sales comptoirs, which ensure that each country participating in the arrangement shall secure its fair share of the foreign business. The French delegates at Geneva have always put that forward as offering one solution of the industrial problem.

Refuse Disposal.

Since the Beccari method of treating refuse by fermentation was introduced from Italy to Cannes, where it is declared to be giving satisfactory results, the system has been receiving a good deal of attention, and it has now been adopted both at Aix-en-Provence and Avignon. The refuse is sorted out in the usual way and the perishable material is placed in closed receptacles, where it undergoes fermentation and is then sold to farmers as a manure. At Cannes there are 104 "cells" or tanks, and at Aix-en-Provence there will be sixty-three, capable of producing something like 6000 tons of manure a year. For the moment the system appears to be of more particular interest for the smaller towns with a surrounding agricultural population, and the incineration process continues to extend in the big towns, the latest to put down a plant being Lyons, which, after sending experts to investigate the methods of refuse treatment in Great Britain, Germany and Switzerland, has decided to place a contract with a firm in Berlin for the construction of the incineration works, the erection to be done almost entirely with French labour and material, the Germans supplying only the special plant for handling and weighing the refuse. The works are required to deal with 420 tons of refuse a day, with a possibility of extension to deal with 700 tons. It appears that preference was shown for the German plant principally on account of the method of sorting the refuse, while it also makes use of the fermentation of vegetable and other fermentable matter by storing it in silos of sufficient capacity to allow of its being disposed of as manure at suitable seasons. The plant recovers metal scrap and the remainder is burnt. Steam will be distributed for heating and electricity will be generated for re-charging secondary batteries for vehicles to be used for the collection of the refuse.

Water Supply.

In view of the growing populations many provincial towns have been obliged to prepare schemes for increasing the water supply, and many tenders are now being invited for the extension of the supply systems. In the Paris suburbs arrangements are being made to lay down more than 60 miles of mains during the present year. In many cases it has been found necessary to replace existing mains with others of larger diameters. The present arrangements for water distribution are generally so deficient that the carrying out of improvements is regarded as urgent, and it is probable that water engineers will be active in the early future. Meanwhile Paris continues to carry out preliminary arrangements for bringing water from the Vals de Loire, and the opposition to the scheme appears to be weakening in view of the difficulty of resisting what is really a vital undertaking for the Metropolis. At recent meetings of the Chambers of Commerce the discussions have turned, not so much upon offering uncompromising opposition as on insisting that if the scheme is carried through the interests of the local populations will be safeguarded.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

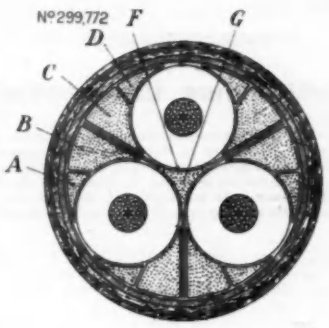
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TRANSMISSION OF POWER.

299,772. October 18th, 1928.—ELECTRIC CABLES, *Compagnie Generale d'Electricite, of 54, rue La Boetie, Paris, France.*

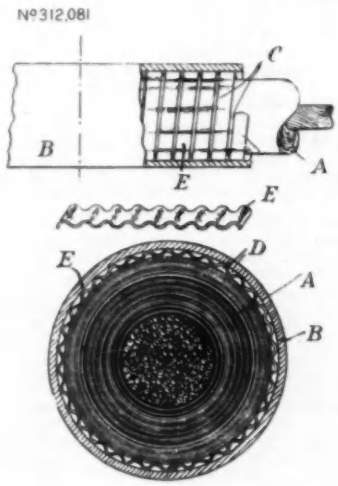
This invention has for its object improvements permitting the cooling of cables to a very much greater extent than is obtained with existing constructions. In the drawing A, B, C, D indicate the elements of subdivided packings. The thin metal sheets or leaves F connect the surface of the central packing G with the conducting surfaces of the packings B and C.



These sheets or leaves are placed in position in assembling the conductors. The heat conducting paths obtained are constituted by a double thickness of metal strip on the adjacent elements A and B and C and D, and by a quadruple thickness of metal strip in the adjacent parts of the elements B and C. The heat developed in the interior of the cable while it is in operation is thus more easily withdrawn than it is in cables not provided with such an arrangement.—*January 20th*, 1930.

312,081. May 17th, 1929.—OIL-FILLED LEAD-COVERED ELECTRIC CABLES, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.* 2.

This invention relates to means whereby an improved arrangement of oil passages possessing advantages over constructions heretofore used is provided. Between the outer surface of the insulation A and the inner surface of the lead sheath B there are circumferentially extending grooves C connected to each other by longitudinally extending passages D. These grooves or passages are formed by means of a corrugated strip E of suitable width, wound spirally around insulation A, the turns being spaced to define a continuous spiral groove. Adjacent spiral grooves are connected to each other by the longitudina passages formed by the corrugated shape of the strip. By the use of a construction which provides circumferentially extending grooves connected by logitudinally extending passages, it is possible to utilise grooves of less depth than have heretofore been considered practical, for, owing to the longitudinally extending passages, if the circumferentially extending grooves

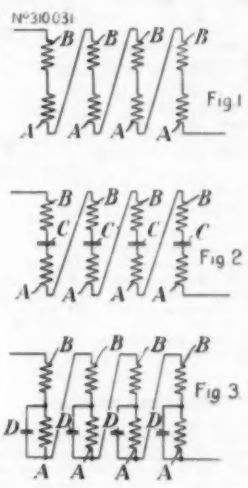


become clogged at any point, the flow of oil is not interrupted. Hitherto, it has been considered necessary to make the grooves of such width and depth that the likelihood of their becoming clogged was remote. In the construction of the cable it is possible to make the grooves C shallower than usual, a feature which results in the saving of material, both as regards to the thickness of the strip E and the overall diameter of the cable. As is well known, oil-filled cable of this type when installed, is provided with suitable containers termed "expansion tanks," into which the oil expands when the cable increases in temperature and from which oil flows into the cable when the oil contracts, owing to decrease in temperature, and in this connection, it is important that the passages for the oil shall not become clogged. Should they become clogged, failure may occur. By the improved construction, the likelihood of the passages for the oil becoming clogged to an extent such as to prevent free expansion or contraction of the oil is remote because of the longitudinally extending cross passages.—*January 16th*, 1930.

FURNACES.

310,031. April 12th, 1929.—ELECTRIC INDUCTION FURNACES, Allmänna Svenska Elektriska Aktiebolaget, of Västeras, Sweden.

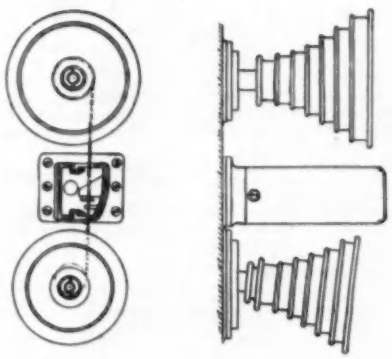
When the power of an electric induction furnace—of the type wherein the induction coil surrounds the furnace crucible and is not penetrated by transformer iron—exceeds some hundreds of kilowatts, difficulties in operating the furnace occur. The pressure for which the primary winding must be insulated should not exceed 1000–2000 volts, having regard to the difficulty of accomplishing a satisfactory insulation at the high temperature prevailing. On the other hand, without special means, the primary winding cannot be fed by a current exceeding a certain value, as that would cause large additional losses on account of skin effect. According to this invention, these difficulties are avoided by dividing the primary winding of the furnace into several series-connected portions between which different winding portions of the generator or transformer feeding the furnace are connected. In all the figures the different portions of the furnace winding are designated by A and the different portions of the generator or transformer winding by B. By such a division into n series-connected portions, no portion of the furnace winding obtains a higher voltage to earth or to adjacent portions than about one nth portion of the total furnace voltage, so that it is possible to construct a furnace n times as great as has hitherto been possible. Whilst it is true that the invention necessitates an increase of the number of conductors between the furnace and the generator or transformer, these are generally placed very close to each other, and in most cases the increase involves no practical inconvenience. If condensers are employed for power factor correction, they are preferably connected separately to the different portions of the furnace winding. They may be series-connected, as shown at C in Fig. 2, or they may be connected in parallel with the portions of the furnace winding as shown at D in Fig. 3.—*January 16th*, 1930.



MACHINE TOOLS AND SHOP APPLIANCES.

323,946. February 6th, 1929.—DIE HOLDERS FOR WIRE-DRAWING BENCHES, Les Frères Bréguet, rue de Carouge 74, Geneva, Switzerland.

This invention appears to amount to little more than the cooling of the dies of high-speed continuous wire-drawing



machines, by enclosing them in a tubular chamber and supplying this chamber with water under pressure. It is pointed out that the water spurting out at the entrance holes for the wire will help to cool the wire and the drawing blocks.—*January 16th*, 1930.

MOTOR CARS AND ROAD TRAFFIC.

323,890. December 13th, 1928.—ELECTRIC DRIVE ARRANGEMENTS FOR MOTOR VEHICLES, Josef Sousedik, of Vsetín, Moravia, Czechoslovakia.

This invention relates to an improved electric drive for motor vehicles in which a motor is used in conjunction with a battery of accumulators, the motor acting at times as a generator. The electric motor driving the vehicle has a series characteristic not only when it operates as a motor, but also when it operates as a generator, so that the mechanical brake is dispensed with. The arrangement consists of one or more electric motors A for driving the vehicle provided with a shunt winding B and a separate excitation C which has a series characteristic, and of a battery of accumulators D. The shunt excitation of the electric motor A is constant, the shunt winding being inserted into the circuit by a reversing switch F before the motor is started. One pole of the armature of the motor A is connected over the reversing switch F to the first cell of the battery D, and its other pole over the switch and a series motor H to the battery switch E. The separate excitation winding C receives the current from a small generator G, which is driven by the series motor H. The generator G is provided with a constant shunt excitation, its shunt winding being connected in series with the winding B. The motor generator G, H, comprises an ordinary series motor H and the generator G, which is suitably dimensioned to supply the current required for the separate excitation winding C of the electric motor A. The motor H is inserted in the main circuit of the motor A driving the vehicle, so that when the load of the latter motor varies, that is to say, when the speed varies, the

excitation of the motor A is also varied. The generator G is provided with separate constant excitation, which is inserted in the circuit of the shunt excitation B of the motor A and provides current for the separately excited winding of the latter motor according to the speed. The reversing switch F serves for the purpose of inserting the shunt winding and the armature or armatures into the circuit as well as for changing over

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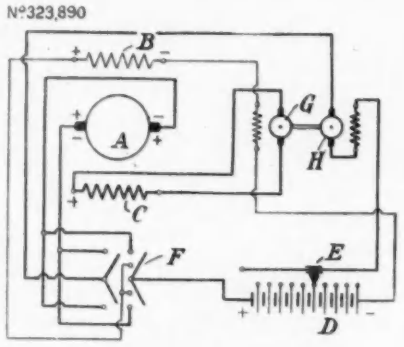

the poles of the armature when the motors driving the vehicle run in the opposite direction. The battery of accumulators D is provided with the battery switch E, the cells of the battery replacing the usual starter when the vehicle is being started, and the braking device when the cells are being disconnected until the whole of the battery is switched off. The first cells of the battery are of larger capacity than the other cells which are less frequently used.—*January 16th*, 1930.

MISCELLANEOUS.

323,706. May 18th, 1929.—PIPE JOINTS, J. Mark, Castle-street Works, Castle-street, Hill Top, West Bromwich.

This invention relates to pipe unions and appears to reside in the fact that the two ferrules are made by wrapping a section strip round a mandrel and welding the ends together. Fig. 1

Nº323,706

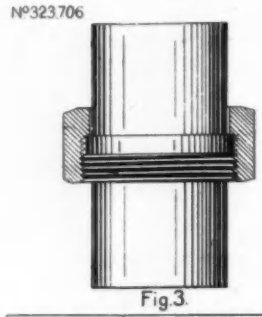

Fig.3.

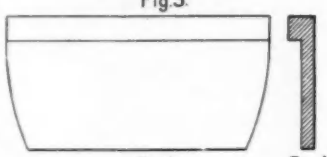

Fig.2. Fig.1

shows the section of the strip and Fig. 2 the way in which the ends are bevelled off on account of the greater amount of metal in the flanged edge. Fig. 3 represents a finished union assembled. —*January 9th*, 1930.

323,982. March 27th, 1929.—SELF-OILING WHEELS, T. C. Wild, 2, Kenwood-road, Sheffield, and A. Oxley, 14, Station-road, Eckington, Derby.

This wheel is presumably intended for colliery tubs or conveyors. It is made hollow to provide a receptacle for oil, which

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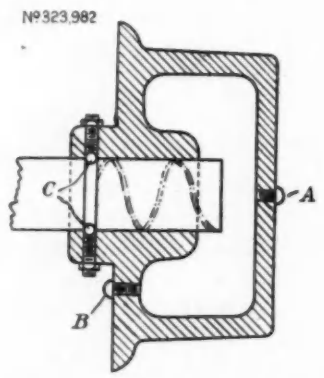

is introduced by either of the screw-stoppered holes A and B. The wheel revolves on a fixed axle and is held in place by the balls C engaging with a groove in the axle. The axle protrudes into the oil containing chamber, so that oil is splashed on to its end and works its way along between the rubbing surfaces to lubricate them.—*January 16th*, 1930.

323,952. February 19th, 1929.—MEANS FOR INDICATING WHEN ELECTRIC CURRENT IS FLOWING IN A CIRCUIT, Julian Henry Runbaken, Maryvale, Hill Top, Wilmslow, Chester, and Godfrey Watkinson Melland, of Min-y-don, Old Colwyn, North Wales.

This invention has for its object to provide improved means for indicating when current is flowing in an electric circuit, the arrangement being particularly advantageous for use in buildings, works, &c., to show whether all the lamps, appliances, and other electricity-consuming means have been put out of circuit. A part A of the main B supplying current to a building is made to form the primary of a transformer, the secondary C of which is in a circuit containing a neon, or equivalent, lamp D. If current is flowing in the main, that is, if any lamps, appliances or machines are left in circuit, the neon lamp will be luminous and serve as an indicator that current is being

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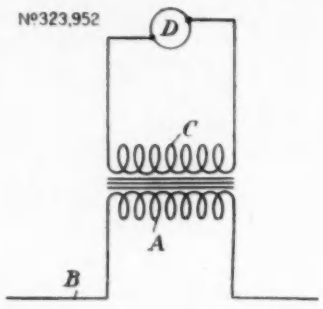

consumed. In a building, this may indicate that lamps have been left burning which ought to have been switched off.—*January 16th*, 1930

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TO-DAY.

INSTITUTION OF AUTOMOBILE ENGINEERS: DERBY GRADUATES.—King's Café, St. Peter's-street, Derby. Annual dinner. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Informal meeting. "The Design of Electrical Machinery," by Mr. J. Rowcroft. 7.30 p.m.

SATURDAY, MARCH 1ST.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—The College of Technology, Sackville-street, Manchester. "The Foundry is a Machine," by Mr. Geo. E. France. 4 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND STUDENTS' SECTION.—Visit to J. Fowler and Co., Ltd., Hunslet, Leeds. 2.15 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Queen's Hotel, Keighley. Annual dinner. 5.45 p.m.

MONDAY, MARCH 3RD.

BIRKBECK COLLEGE.—Breams-buildings, Fetter-lane, E.C. 4. "An Isometric Diagram of the Construction of the Dome of St. Paul's Cathedral," by Professor Beresford Pite. 5.30 p.m.

BRADFORD ENGINEERING SOCIETY.—In the Hall of the Bradford Technical College. "The Electric Driving of Textile Factories, with Special Reference to Spinning," illustrated by lantern slides, by Mr. A. Brier. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: BRISTOL SECTION.—The Merchant Venturers' Technical College, Unity-street, Bristol. "Combustion in Diesel Engines," by Mr. H. R. Ricardo. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—Hotel Metropole, Leeds. Annual dinner. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Graduates' Section, London. Annual meeting. Informal discussion on "Workshop Practice at Home and Abroad." 7 p.m.

KING'S COLLEGE ENGINEERING SOCIETY.—King's College, London, W.C. 2. "Construction and History of Hadrian's Wall," by Mr. J. M. Kamcké. 5.15 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C. 4. "Some Problems on Passenger Train Operation," by Mr. C. R. Clinker. 7.30 p.m.

SOCIETY OF ENGINEERS.—Geological Society, Burlington House, Piccadilly, W. "Machine Tools," by Mr. J. Pickin. Followed by a film entitled "A British Key Industry." 5.30 p.m.

TUESDAY, MARCH 4TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Society of Arts, John-street, Adelphi, W.C. 2. General meeting. "Combustion in Diesel Engines," Mr. H. R. Ricardo. 7.45 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, W. 1. "X-Ray Determination of the Structure of Cellulose," by Sir William Bragg, F.R.S. 5.15 p.m.

WEDNESDAY, MARCH 5TH.

INSTITUTION OF CHEMICAL ENGINEERS.—In the Rooms of the Geological Society, Burlington House, London, W. 1. "The Formation and Growth of Crystals," by Professor W. E. Gibbs. 8 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Students' meeting. "Long-distance Gas Transmission," by Mr. H. F. H. Jones. 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Grand Hotel, Sheffield. "Deterioration of Structures Exposed to Sea Action," by Professor S. M. Dixon. 7.15 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Savoy-place, Victoria Embankment, W.C. 2. "Some Developments of the Piezo-electric Crystal as a Frequency Standard," by Mr. H. J. Lucas; "The Valve-maintained Quartz Oscillator," by Mr. J. E. P. Vigoureux.

INSTITUTION OF SANITARY ENGINEERS.—296, Vauxhall Bridge-road, S.W. 1. "Civic Sanitary Engineering," by Alderman G. Marlow Reed. 6 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS AND MANCHESTER METALLURGICAL SOCIETY.—Engineers' Club, Albert-square, Manchester. "The Use and Abuse of Equilibrium Diagrams," by Professor F. C. Thompson. 7.15 p.m.

THURSDAY, MARCH 6TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. "The Manufacture of Glass and Some of its More Interesting Properties," by Mr. C. A. Coad Pryor. 7.30 p.m.

KING'S COLLEGE ENGINEERING SOCIETY.—King's College, London, W.C. 2. "Aircraft Construction and Types," by Mr. E. Nicholl. 5.15 p.m.

ROYAL AERONAUTICAL SOCIETY.—At the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. "The Resistance of Air-cooled Engines and the Townend Ring," by Mr. H. C. H. Townend. 6.30 p.m.

FRIDAY, MARCH 7TH.

CHEMICAL ENGINEERING GROUP.—Institution of Engineers and Shipbuilders, Glasgow. Joint meeting with the Glasgow Section. "The Insulation of Heated and Cooled Surfaces," by Mr. J. S. F. Gard and Mr. R. F. Robinson. 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS.—Connaught Rooms, Great Queen-street, London, W.C. Annual dinner. 7 for 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Extra general meeting. "The Strength and Design of Fusion Welds for Unfired Pressure Vessels," by Mr. L. W. Schuster. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Ordinary meeting. "Chile and Engineering in Chile," by C. J. Hartley, M. Inst. C.E. To be read by P. C. Dewhurst, M.I. Mech. E. 7.30 p.m.

OLD CENTRALIANS.—Hotel Cecil, Strand, W.C. 2. Twenty-seventh annual dinner. 7.15 for 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Angler Fishes," by Mr. C. T. Regan, F.R.S. 9 p.m.

SATURDAY, MARCH 8TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Lecture Hall, Corporation-street, Taunton. Annual District meeting. 11 a.m.

MONDAY, MARCH 10TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Annual general meeting. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. "The Mercédès-Benz Diesel Engine," by Mr. W. H. Goddard. 7 p.m.

KING'S COLLEGE ENGINEERING SOCIETY.—King's College, London, W.C. 2. "Pulverised Fuel," by Mr. A. H. S. Oddy. 5.15 p.m.

TUESDAY, MARCH 11TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—In the Municipal College, Ormerod-road, Burnley. "Jobbing Castings," by Mr. A. Sutcliffe, illustrated by lantern slides. 7.15 p.m.

INSTITUTE OF MARINE ENGINEERS.—The Minories, London, E.C. 3. "The Advantages to the Shipowner of Closer Co-operation Between the Naval Architect and the Marine Engineer," by Mr. A. T. Wall. 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Papers to be submitted for discussion: "Reconstruction of Liskeard Viaduct and Scheme for Reconstruction of the Approach Spans of the Royal Albert Bridge, Saltash," by Mr. Harold Duke Smith; "Reconstruction of Approach Spans, Royal Albert Bridge, Saltash," by Mr. Frank Gibbons; "Reconstruction of Kent and Leven Viaducts, Furness Section of the London, Midland and Scottish Railway," by Mr. James Alexander. 6 p.m.

WEDNESDAY, MARCH 12TH.

INSTITUTE OF METALS.—In the Hall of the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Twenty-second annual general meeting. Reading and discussion of papers (see page 134).

INSTITUTE OF METALS.—At the Hotel Metropole, Northumberland-avenue, S.W. 1. Annual dinner and dance. 6.45 for 7 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Informal meeting. Subject for discussion, "Land Reclamation Work," by Mr. F. M. G. Du-Plat-Taylor. 6 p.m.

THURSDAY, MARCH 13TH.

INSTITUTE OF MARINE ENGINEERS: JUNIOR SECTION.—In the Library of the Institute, The Minories, London, E.C. 3. Informal address, "Marine Boilers: Their Troubles and Maintenance," by Engr.-Lieut.-Comr. H. S. Humphreys, R.N. (Ret.). 6.30 p.m.

INSTITUTE OF METALS.—In the Hall of the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Twenty-second annual general meeting. Reading and discussion of papers (see page 134). 10 a.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Lecture Hall, Devonport Technical College, Plymouth. "The Inspection of Metals and their Alloys," by Capt. L. W. Johnson. 8 p.m.

FRIDAY, MARCH 14TH.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-Ferrous Section of the Applied Science Department of the University, St. George's-square. "Electric Heat Treatment Furnaces," by Mr. A. Glynne Lobley. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "An Outline of Siemens No. 50 Telephone Switching Equipment," by Mr. W. A. Sallis. 7.30 p.m.

MONDAY, MARCH 17TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: SCOTTISH CENTRE.—Royal Technical College, Glasgow. "Combustion in Diesel Engines," by Mr. H. R. Ricardo. 7.30 p.m.

KING'S COLLEGE ENGINEERING SOCIETY.—King's College, London, W.C. 2. "Haulage in Coal Mines," by Mr. W. H. Dormer. 5.15 p.m.

TUESDAY, MARCH 18TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the Chamber of Commerce, New-street, Birmingham. "Nickel-chromium Alloys," by Mr. W. R. Barclay. 7 p.m.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Annual general meeting, short paper competition. 7.30 p.m.

WEDNESDAY, MARCH 19TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Metropole Hotel, King-street, Leeds. "Organisation of Public Service Motor Vehicle Repair and Maintenance Systems," by Mr. W. Lewis Morgan. 7.15 p.m.

THURSDAY, MARCH 20TH.

KING'S COLLEGE ENGINEERING SOCIETY.—King's College, London, W.C. 2. "Motoring: Its Progress in the Last Thirty Years," by Mr. S. B. Thomas. 5.15 p.m.

SATURDAY, MARCH 22ND.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND STUDENTS' SECTION.—Visit to the Yorkshire Copper Works at Stourton, Leeds. 2.30 p.m.

SATURDAY, MARCH 29TH.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.—Trocadero Restaurant, London. Annual dinner.